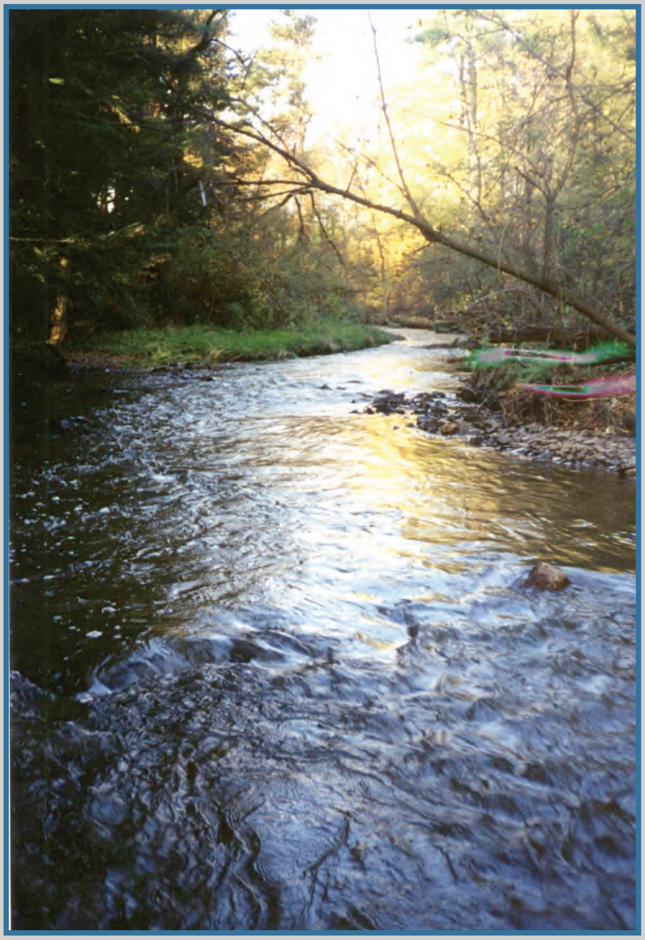
Phase 1 Comprehensive Water Supply Plan

Ten Mile/Narragansett Bay and Mt. Hope Bay Shore

Inventory of Public Water Supply Needs and Existing and Potential Supply Sources



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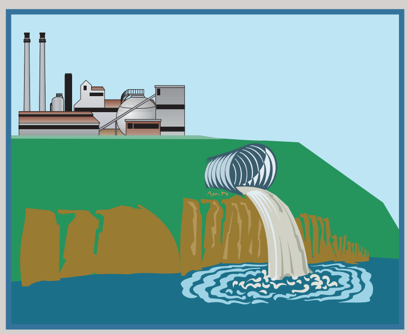

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EXECUTIVE SUMMARY

Horsley & Witten, Inc. (H&W) was contracted by the Massachusetts Department of Conservation and Recreation (formerly the Department of Environmental Management) to develop the first phase of a Comprehensive Water Supply Plan for the Ten Mile/Narragansett Bay and Mt. Hope Bay Shore Watersheds. The overall purpose of the study is to determine the future water use needs for selected communities in Southeastern Massachusetts and to compare these needs with three potential constraints. The first potential constraint is the permitted volume of withdrawal for each community. The second potential constraint is the ability to site new groundwater withdrawals if necessary. The third potential constraint involves an assessment of the existing stresses to the underlying aquifers in each community.

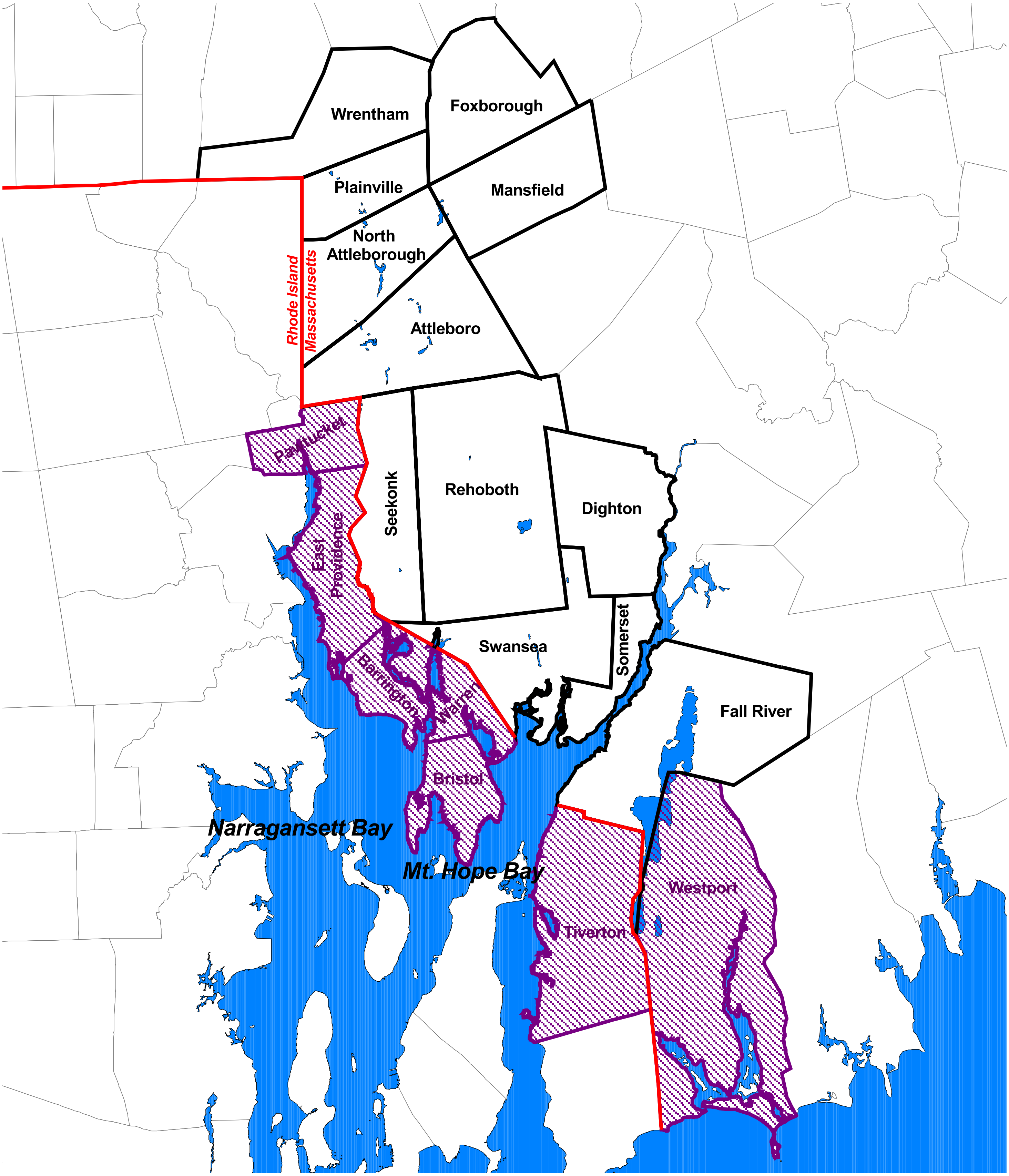
The plan focuses on twelve communities in southeastern Massachusetts, which overlay areas of three major basins (Figures 1 and 2). The twelve communities are Attleboro, Dighton, Fall River, Foxboro, Mansfield, North Attleborough, Plainville, Rehoboth, Seekonk, Somerset, Swansea, and Wrentham. Other communities were incorporated into the water budget analysis since sub-basin boundaries extended beyond the twelve primary communities. The only other Massachusetts community incorporated in these analyses was Westport, MA. In Rhode Island, Pawtucket, East Providence, Barrington, Bristol, Warren and Tiverton were also part of the preliminary water budget calculations.

The project combines data inventory and analyses to assess existing water supply conditions and to project potential future demands. Information from local, regional, state and national agencies were integrated into a five-stage analyses that combines the standardization of disparate data sets with analytical techniques for the purposes of long term water supply forecasting. The five stages of the project are:

1. Project Water Supply Needs Through 2020;
2. Identify and Map Existing Water Supplies;
3. Identify Areas for Future Water Supply Exploration;
4. Map Interim Wellhead Protection Areas (IWPAs); and
5. Develop Preliminary Water Budget Analyses on a Subwatershed Level.

The development of projected water supply needs included:

1. Population projections based on the Southeastern Regional Planning & Economic Development District (SRPEDD) and the Massachusetts Institute for Social and Economic Research (MISER) population estimates,
2. Water needs projections based on the Department of Environmental Protection (DEP) Annual Statistical Reports (ASRs) and the Generic Water Needs Forecast Methodology, and
3. A comparison of forecasted water needs with the safe yields, permitted withdrawals, and current pumping capacities of the twelve communities.



Legend

Towns Identified by DCR for Water Needs Analysis

Additional Towns Included in Water Budget Analysis

State Line

Surface Water

N

0 5 Miles

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Municipality Locus Map

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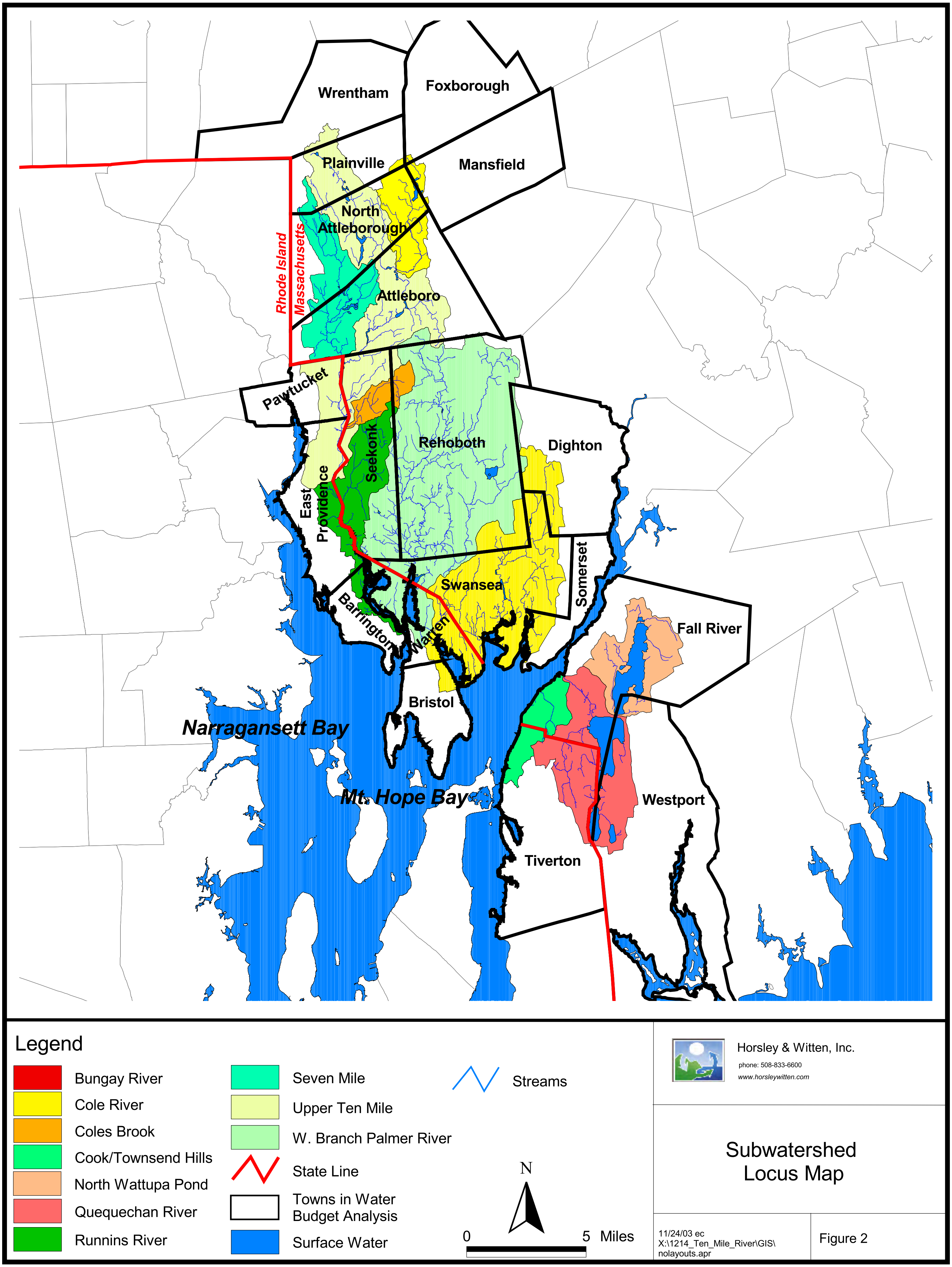
Figure 1



Subwatershed Locus Map

Figure 2

Based on the current permitted withdrawal for each community and the projected future water needs, six communities do not need additional supply. The six communities are Dighton, Foxboro, Plainville, Somerset, Swansea, and Wrentham. Five other communities, including Attleboro, Fall River, Mansfield, North Attleborough, and Seekonk, will need additional water withdrawals to meet their future water needs. The Town of Rehoboth currently does not have a public water system.

To identify and map all existing water supplies, the MassGIS (Massachusetts Geographic Information Systems) public water supply coverage was cross-referenced with the DEP Southeast Region Office Water Management Act database. Wells within the database were projected into ArcView GIS using the reported latitude and longitude coordinates and corrected using qualitative judgment where necessary. H&W gathered data regarding permitted pumping rates from the SERO database and cross-referenced with ArcView data stored within the MassGIS database. The final collection of wells was stored in both database and GIS format. The new coverage includes 103 withdrawals with reported permitted pumping rates and 40 with no reported pumping rates for a total of 143 withdrawals.

To identify areas for future water supply exploration, spatial datalayers within the MassGIS data library were divided into categories of "opportunities" and "constraints". "Opportunity" coverages were comprised of aquifer features that represent areas of potentially significant groundwater yield. "Constraints" included those areas that would preclude the establishment of wells such as sensitive habitat areas, urbanized land use, or fixed radii around contaminated sites. The resulting areas of opportunity collectively cover approximately 10.9 square miles throughout the 12 communities and have been stored in GIS format.

To inventory the wellhead protection areas surrounding supply wells, the GIS based supply well coverage developed in Task 2 was compared with MassGIS coverage for Zone 2 and IWPAs. This exercise confirmed that all public supply wells were accompanied by either a Zone 2 boundary or an IWPA.

The final task, developing a water budget for specified subwatersheds, built upon the previous tasks and was performed using data exclusively within ArcView GIS. The water budgets were performed on sub-basins delineated using MassGIS sub-basin coverage along with guidance from the Massachusetts Department of Conservation and Recreation (DCR). The GIS based model uses the pumping records gathered from municipal Annual Statistical Reports (ASRs) to examine water withdrawals in "average annual" and "peak summer" withdrawal scenarios. Digitized water supply system and sewer service envelopes were used to develop a spatial approach to calculating return of water to the aquifer through septic systems or loss of water to the aquifer via centralized sewer disposal. The net loss of water to the aquifer within each subwatershed was then compared to different stream flow statistics to assess the relative impacts of water consumption on the hydrologic system.

The results of the preliminary water budget analyses suggest that four subwatersheds show net losses from the aquifer in both peak summer and average annual conditions: the Bungay River, Cole River, Coles Brook, and Upper Ten Mile River. Five subwatersheds show gains from interbasin transfers: Cook/Townsend Hills, the Quequechan River, the Runnins River, the Seven Mile River, and the West Branch Palmer River. One subwatershed, North Watuppa Pond, showed no significant change in either scenario.

The results of the preliminary water budget analyses for each subwatershed (Task 5) were compared with the results of the water needs assessment (Task 1). The comparisons with Task 1 suggest that, of the five communities identified as needing future increases in permitted volumes, four contain aquifers that did not show losses in the water budget analyses. These communities include Fall River, Attleboro, North Attleborough and Seekonk. The majority of the fifth community, Mansfield, lies outside the study subwatersheds and may be able to establish sustainable wells in those outlying areas.

The results of the preliminary water budget analyses (Task 5) were also compared with the identification of potential future water supply exploration (Task 3). This comparison was used to add another "constraint" to those originally applied within Task 3 relative to future water supply exploration. The assumption in this comparison is that there would be no future exploration where aquifers showed a loss within the preliminary water budget. The comparison revealed that, although each community showed potential areas under Task 3, only four communities showed potential areas for future water supply exploration after the stressed aquifers were applied as a constraint. These remaining communities include Fall River, Rehoboth, Seekonk, and Swansea. Of the 10.9 square miles originally identified within Task 3, 3.7 square miles remained.

During the development of this study, the events of September 11, 2001 radically changed the way water supply data are perceived in the Commonwealth of Massachusetts. Because of heightened awareness of the threat of terrorist attacks, data that were once readily available to the public (e.g. pumping records, water supply location and water system distribution maps) were not made available to H&W for a period of many months while a protocol for sharing these data was developed. As a result, much of the data used in these analyses were shared with H&W under a restricted agreement. In particular, water supply system mapping was used to develop the preliminary subwatershed water balances and is regarded by state and local officials as confidential material. The water supply system envelopes digitized by H&W are therefore not shown as part of this report.

INTRODUCTION

Horsley & Witten, Inc. (H&W) was contracted by the Massachusetts Department of Conservation and Recreation (DCR, formerly the Department of Environmental Management) to develop the first phase of a Comprehensive Water Supply Plan for the Ten Mile/Narragansett Bay and Mt. Hope Bay Shore Watersheds. The overall purpose of the study is to determine the future water use needs for selected communities in Southeastern Massachusetts and to compare these needs with three potential constraints. The first potential constraint is the permitted volume of withdrawal for each community. The second potential constraint is the ability to site new groundwater withdrawals if necessary. The third potential constraint involves an assessment of the existing stresses to the underlying aquifers in each community.

The project combines data inventory and analyses to assess existing water supply conditions and to project potential future demands. Information from local, regional, state and national agencies were integrated into a five-stage analyses that combines the standardization of disparate data sets with analytical techniques for the purposes of long term water supply forecasting. The five stages of the project are:

1. Project Water Supply Needs Through 2020;
2. Identify and Map Existing Water Supplies;
3. Identify Areas for Future Water Supply Exploration;
4. Map Interim Wellhead Protection Areas (IWPAs); and
5. Develop Preliminary Water Budget Analyses on a Subwatershed Level.

The following report provides detailed descriptions of the technical approaches applied to each task, the results of analyses, and a discussion of these results. The report is organized to reflect five overall stages, with a discussion of how these analyses are inter-related at the end of Task 5.

1.0 PROJECTED WATER SUPPLY NEEDS THROUGH 2020

H&W conducted a water needs forecast for the 12 communities identified in the Comprehensive Water Supply Plan Phase 1, which fall within the Ten Mile River, Narragansett Bay and Mt. Hope Bay Shore Watersheds. The 12 communities are Attleboro, Dighton, Fall River, Foxboro, Mansfield, North Attleborough, Plainville, Rehoboth, Seekonk, Somerset, Swansea, and Wrentham.

The scope of work included population projections based on the Southeastern Regional Planning & Economic Development District (SRPEDD) and the Massachusetts Institute for Social and Economic Research (MISER) population projection estimates, water needs projections based on the Department of Environmental Protection (DEP) Annual Statistical Reports and the Generic Water Needs Forecast Methodology developed by the Massachusetts Water Resources Commission, and a comparison of forecasted water needs with the safe yields, permitted withdrawals, and current pumping capacities of the 12 communities. MISER's research involves planning, strategy, and forecasting, with a focus on social, economic, and demographic issues. This work is designed to formulate new public policy for use by government policy makers, as well as to develop information systems showing the relationship between public policy and the economy of Massachusetts and New England.

1.1 Population Forecast

H&W compiled the latest population projections developed by the SRPEDD, MAPC, and MISER. The SRPEDD and MAPC data have been updated with the census 2000 data and the projected populations are completed for 2010 and 2020. H&W interpolated the data for 2005 and 2015 by using the average natural logarithmic growth rate used in the projection. The populations of Foxborough and Wrentham are not included in the SRPEDD database, but they are included in the MAPC database. In addition, Swansea Water Department demonstrated that the Town has a higher population than the 2000 Census through the use of more recent study data provided by Comprehensive Environmental Inc. Therefore, the Swansea population projection was adjusted to reflect these new data. SRPEDD and the MAPC census data are summarized in Table 1.

Table 1. Population Forecast Based on SRPEDD/MAPC Data

Community	Census	SRPEDD/MAPC Data				% increase
	Population					
	2000	2005	2010	2015	2000	From 2000 to 2020
Attleboro	42,068	43,721	45,440	47,096	42,068	16.0
Dighton	6,175	6,605	7,065	7,496	7,954	28.8
Fall River	91,938	92,077	91,938	92,355	92,495	0.6
Foxboro	16,246	16,098	16,940	17,290	17,148	5.6
Mansfield	22,414	24,739	27,305	29,649	32,195	43.6
North Attleborough	27,143	28,118	29,127	30,103	31,111	14.6
Plainville	7,683	8,115	8,572	9,006	9,462	23.2
Rehoboth	10,172	10,874	11,624	12,329	13,076	28.5
Seekonk	13,425	13,665	13,910	14,150	14,395	7.2
Somerset	18,234	18,536	18,842	19,144	19,450	6.7
Swansea	17,359	17,648	17,942	18,231	18,525	6.7
Wrentham	10,554	10,678	11,392	11,686	11,703	10.9
Total	283,411	290,874	300,097	308,535	316,326	11.6

The latest MISER data were developed in 1999. Fortunately, the Massachusetts Highway Department (MassHighway) completed the population projection for the region using the MISER data and projected the population to 2025. Therefore, H&W has used the MassHighway data for this study. The only adjustment is made to Swansea. The MassHighway data are summarized in Table 2.

Table 2. Population Forecast Based on MISER Data

Community	Census	Population				% increase
	2000	2005	2010	2015	From 2000 to 2020	from 2000 to 2020
Attleboro	42,068	44,044	45,610	47,650	49,689	18.1
Dighton	6,175	6,763	6,960	7,422	7,884	27.7
Fall River	91,938	93,285	94,226	95,739	97,251	5.8
Foxboro	16,246	16,645	16,901	17,161	17,425	7.3
Mansfield	22,414	24,454	26,116	28,114	30,112	34.3
North Attleborough	27,143	28,346	29,174	30,418	31,552	16.2
Plainville	7,683	8,253	8,423	8,914	9,405	22.4
Rehoboth	10,172	11,238	11,911	12,847	13,783	35.5
Seekonk	13,425	13,959	14,128	14,565	15,002	11.7
Somerset	18,234	18,678	18,743	19,114	19,484	6.9
Swansea	17,359	17,781	18,052	18,327	18,606	7.2
Wrentham	10,554	11,320	11,778	12,254	12,749	20.8
Total	283,411	294,766	302,022	312,525	322,942	13.9

1.2 Water Needs Forecast

The water needs forecast for each community was calculated according to the Generic Water Needs Forecast Methodology, developed by the River Basin Planning Program of the Massachusetts Water Resources Commission. The method is described in Appendix A.

The average water supply needs for each community were calculated from the amount of total water pumped and reported to the Department of Environmental Protection in the 1998 to 2002 Annual Statistical Reports (Appendix B). The same reports also had the consumption information breakdown for water usages. The pumping data were used to determine the current town-wide and residential consumption per capita per day, non-residential consumption per day, and unaccounted-for water. Once these parameters were established, future water demands were estimated based on future population projections, town commercial and industrial growth rates, previous town water demand data, and percentages of the unaccounted-for water.

The Generic Water Needs Forecast Methodology specified two methods for water supply projections. Communities having a residential consumption rate of less than 80 gallons per capita per day, and/or an unaccounted-for water percentage below 15%, were estimated using Method 1. However, if the communities had a current residential consumption rate of 80 gallons per capita per day or more, and an unaccounted-for water percentage of 15% or more, Method 2 was used instead. Method 2 primarily restricted the residential consumption rate to 70 gallons per capita per day, and the unaccounted-for water percentage to 10%.

Another factor considered in the water supply forecast was the non-residential growth rate, comprised of the commercial and industrial growth rate. This growth rate was obtained by using either the town's planning data or past water demand records. If the town's planning data were available, the growth rate was based on these data. However, if the town's planning data were not available, the growth rates were based on the previous nine years of water consumption data. Growth rates are presented within the calculation spreadsheets contained in Appendix C, D, and E.

The water need projections from 2005 to 2020 are summarized in Tables 3 and 4. The detailed calculation worksheets based on SRPEDD/MAPC population data are included in Appendix D. Appendix E contains the detailed calculation worksheets based on the MISER population data.

Table 3. Water Need Projection Based on SRPEDD/MAPC Data (reported in MGD)

Community	1998 to2002	2005	2010	2015	2020	% increase
	------------average daily demand------------					From 2000 to 2020
Method 1						
Dighton	0.47	0.50	0.53	0.56	0.60	27.7
Fall River	13.67	13.51	13.49	13.55	13.57	-0.7
Foxboro	2.02	2.00	2.11	2.15	2.13	5.5
Mansfield	2.00	2.20	2.43	2.64	2.87	43.5
North Attleborough	2.91	2.96	3.07	3.17	3.27	12.4
Plainville	0.65	0.66	0.7	0.73	0.77	18.5
Seekonk	1.46	1.48	1.51	1.54	1.56	6.9
Swansea	1.27	1.29	1.32	1.34	1.36	7.1
Subtotal	**24.45**	**24.6**	**25.16**	**25.68**	**26.13**	**6.9**
Method 2						
Attleboro	5.19	5.36	5.53	5.7	5.88	13.3
Somerset	3.11	3.3	3.49	3.68	3.68	24.1
Wrentham	0.99	1.00	1.05	1.07	1.07	8.1
Subtotal	**9.29**	**9.66**	**10.07**	**10.45**	**10.81**	**16.4**
Total	**33.74**	**34.26**	**35.23**	**36.13**	**36.94**	**9.5**

Table 4. Water Needs Projections Based on MISER Data (reported in MGD)

Community	1998 to 2000	2005	2010	2015	2020	% increase
	------------average daily demand------------					From 2000 to 2020
Method 1						
Dighton	0.47	0.51	0.53	0.56	0.59	25.5
Fall River	13.67	13.68	13.82	14.04	14.26	4.3
Foxboro	2.02	2.07	2.1	2.13	2.17	7.4
Mansfield	2.00	2.18	2.33	2.51	2.68	34.0
North Attleborough	2.91	2.99	3.07	3.20	3.32	14.1
Plainville	0.65	0.67	0.69	0.73	0.77	18.5
Seekonk	1.46	1.52	1.53	1.58	1.63	11.6
Swansea	1.27	1.30	1.32	1.34	1.36	7.1
Subtotal	**24.45**	**24.92**	**25.39**	**26.09**	**26.78**	**9.5**
Method 2						
Attleboro	5.19	5.39	5.55	5.76	5.97	15.0
Somerset	3.11	3.32	3.47	3.67	3.87	24.4
Wrentham	0.99	1.04	1.08	1.11	1.14	15.2
Subtotal	**9.29**	**9.75**	**10.10**	**10.54**	**10.98**	**18.2**
Total	**33.75**	**34.68**	**35.49**	**36.63**	**37.76**	**11.9**

1.3 Water Needs Comparison

H&W has compiled the current water supply information to include safe yields, permitted withdrawals, and pumping capacities for each water source as provided by the 12 communities (Appendix F). It is important to note that the concept of "safe yield" refers to the capacity of the pump to provide the permitted volume of water from a mechanical perspective. This definition is derived from DEP Water Supply Guidelines. Safe yield, for the purposes of this discussion, does not refer to the capacity of the aquifer to supply the permitted withdrawal. This information has been totaled for each town, and a summary is shown below in Tables 5 and 6, along with the future water need projections from Tables 3 and 4 above.

Table 5. Water Supply Needs Comparison with SRPEDD/MAPC Data (reported in MGD)

Communities	Safe Yield (GW[1])	Permitted Withdrawal (GW+SW[2])	Pump Capacity	2000	2005	2010	2015	2020
				--------------average daily demand--------------				
Attleboro	4.4	5.7	8.5	5.19	5.36	5.53	5.7	5.88
Dighton	0.7	0.7	1.3	0.47	0.5	0.53	0.56	0.6
Fall River	24	14.6	34.6	13.67	13.51	13.49	13.55	13.57
Foxboro	5.9	5.5	4.2	2.02	2.0	2.11	2.15	2.13
Mansfield	9.3	2.4	9.6	2.0	2.2	2.43	2.64	2.87
North Attleborough	2.8	2.8	n/a	2.91	2.96	3.07	3.17	3.27
Plainville	1.5	1.2	1.6	0.65	0.66	0.7	0.73	0.77
Rehoboth	No public water system							
Seekonk	5.3	1.5	4.3	1.46	1.48	1.51	1.54	1.56
Somerset	5.6	4.2	4.6	3.11	3.3	3.49	3.68	3.86
Swansea	1.5	1.5	3.5	1.27	1.29	1.32	1.34	1.36
Wrentham	2.3	2.3	2.3	0.99	1.0	1.05	1.07	1.07
Total	**62.4**	**41.5**	**74.5**	**33.74**	**34.26**	**35.23**	**36.13**	**36.94**

[1] groundwater; [2] surface water

Table 6. Water Supply Needs Comparison with MISER Data (reported in MGD)

Communities	Safe Yield (GW[1])	Permitted Withdrawal (GW+SW[2])	Pump Capacity	2000	2005	2010	2015	2020
				--------------average daily demand--------------				
Attleboro	4.4	5.7	8.5	5.19	5.39	5.55	5.76	5.97
Dighton	0.7	0.7	1.3	0.47	0.51	0.53	0.56	0.59
Fall River	24	14.6	34.6	13.67	13.68	13.82	14.04	14.26
Foxboro	5.9	5.5	4.2	2.02	2.07	2.1	2.13	2.17
Mansfield	9.3	2.4	9.6	2.00	2.18	2.33	2.51	2.68
North Attleborough	2.8	2.8	n/a	2.91	2.99	3.07	3.2	3.32
Plainville	1.5	1.2	1.6	0.65	0.67	0.69	0.73	0.77
Rehoboth	No public water system							
Seekonk	5.3	1.5	4.3	1.46	1.52	1.53	1.58	1.63
Somerset	5.6	4.2	4.6	3.11	3.32	3.47	3.67	3.87
Swansea	1.5	1.5	3.5	1.27	1.3	1.32	1.34	1.36
Wrentham	1.4	1.4	2.3	0.99	1.04	1.08	1.11	1.14
Total	**62.4**	**41.5**	**74.5**	**33.74**	**34.67**	**35.49**	**36.63**	**37.76**

1.4 Conclusion

Based on the current permitted withdrawal for each community and the projected future water needs, six communities do not need additional supply. The six communities are Dighton, Foxboro, Plainville, Somerset, Swansea, and Wrentham. Five other communities, including Attleboro, Fall River, Mansfield, North Attleborough, and Seekonk, will need additional water withdrawals to meet their future water needs. The Town of Rehoboth currently does not have a public water system.

2.0 IDENTIFICATION AND MAPPPING OF EXISTING WATER SUPPLIES

The goal of this task was to compile existing data for public and private withdrawals from different state agencies and combine these data into well-organized ArcView GIS coverages. To accomplish this, H&W consulted two state databases to map the existing water supplies within the twelve subject communities. (A third database, RIGIS, was used to map wells within Rhode Island for Task Five). These databases included the MassGIS spatial database for library and the Southeast Regional Office (SERO) Massachusetts Water Management Act (WMA) database. These databases were cross-referenced using both visual and qualitative methods to develop a final set of comprehensive well data.

2.1 Development of the Database

Using the MassGIS coverage as a locus, the wells found within the WMA database were cross-referenced by projecting them onto the same map using the specified latitude and longitude coordinates. Where well locations matched, the names within the data were checked to ensure these wells were the same. All of these matches proved to be redundancies and the WMA points were therefore eliminated.

Where well locations did not show a match, the names from the WMA database were again checked against the MassGIS coverage. In cases where the same well from the WMA database appeared in a different location from the MassGIS coverage, the MassGIS location was assumed to be correct. In three instances, points unique to the WMA database (not found in MassGIS coverage) appeared in locations that were obviously incorrect. These supplies were for the North Attleborough National Fishery, a Morse Brothers, Inc. cranberry bog, and Byrne Sand and Gravel. These points were moved using best professional judgment based on withdrawal description or the provided address.

The final inventory of wells was categorized into two shapefiles for WMA and non-WMA wells. The data supplied by MassGIS was linked to the relevant data within the WMA database to create more detailed attribute information for the spatial coverages. Where permitted pumping volumes were absent within the WMA database, further data research was performed using non-spatial ArcInfo data tables within the MassGIS library. These tables are included as supplementary data within the MassGIS library but have no associated visual display. Data from these secondary sources accounted for approximately 20% of the overall missing pumpage volumes. The resulting withdrawal database contains 143 withdrawals, of which 103 have an associated average daily pumping rate. The data tables are included in the digital coverages (CD) provided as an attachment to the report. These data are considered confidential by state and local officials and will be distributed at the discretion of DCR.

2.2 Recommendations for Further Study

The database created for this task combines two primary sources of well location/ withdrawal for this region and one secondary source. The MassGIS database provides the highest quality location data for these wells while the WMA database adds additional locations as well as the highest quality permitted withdrawal data. Further investigation into MassGIS archives provided some additional pumping and general withdrawal information. However, 40 withdrawals within the subject communities still have no reported withdrawal within the database. These withdrawals represent a combination of existing and potential water supplies, therefore it is possible that the withdrawals for potential supply were not determined at the time these data were compiled.

It is therefore recommended that further research be performed to fill any withdrawal volume data gaps within the database. Also, it is recommended that the three previously mentioned withdrawals with poor quality location data be field checked to determine the appropriate latitude and longitude for the database.

3.0 IDENTIFICATION OF AREAS FOR FUTURE WATER EXPLORATION

H&W used available datalayers from MassGIS to isolate potential areas for future groundwater exploration. The datalayers within the library were inventoried and divided into two general categories: “opportunities” and “constraints”. A summary of the datalayers attributed to each category is provided below in Table 7. Metadata for these files are included in Appendix G.

Table 7. MassGIS Datalayers Used to Isolate Potential Areas for Groundwater Exploration

Datalayers	Application
Opportunities for Exploration	
Aquifers	Regional spatial distribution of “high” and “medium” yield aquifers throughout the Commonwealth.
Land Use	Land use by town that includes areas where exploration would most likely take place (forest, open space, etc)
Constraints on Exploration	
Underground Storage Tank (UST) Locations	500-foot radius was drawn around each UST
Vernal Pools	350-foot radius drawn around each vernal pool within the study area

Table 7. MassGIS Datalayers Used to Isolate Potential Areas for Groundwater Exploration (cont'd.)

Datalayers	Application
Constraints on Exploration	
Solid Waste Facilities	1,000-foot buffer drawn around each solid waste facility in the study area
Wetlands	Wetland coverage provided on a 1:5,000 scale
Major Rivers, Streams, and Ponds	State-wide coverage for major surface water bodies
2001 Orthophotos	1:5,000 color orthophotos used to confirm constraints based on land use

Once these datalayers were compiled, ArcView GIS was used to eliminate the areas of constraint from within the areas of opportunity. For example, wetland areas overlaying the aquifer were subtracted since exploration would be difficult within wetland boundaries. Once all of the constraints were subtracted in this manner, the remaining areas of opportunity served as a preliminary locus for potential future source water exploration. This datalayer was created solely by cross-referencing the attribute data tables compiled within MassGIS. Once these areas of potential exploration were established, recently issued orthophotography was used to refine the preliminary analyses. The areas for potential groundwater exploration were refined where the datalayer covered well-developed areas or major roads. The remaining aquifer areas are sparsely spread across the study region and cover nearly 7,000 acres or approximately 10.5 square miles (Appendix I). The largest concentrations of potential exploration area by municipality are found in the communities of Mansfield (2.2 square miles) and Rehoboth (2.6 square miles). Table 8 summarizes the extent of the potential areas for groundwater exploration developed using the GIS-based approach.

Table 8. Coverage of Areas for Potential Groundwater Exploration by Municipality

Municipality	Area for Potential Groundwater Exploration (Acres)
Attleboro	498
Dighton	205
Fall River	99
Foxborough	478
Mansfield	1,430
North Attleborough	339
Plainville	234
Rehoboth	1,673
Seekonk	402
Somerset	6
Swansea	778
Wrentham	585
Total	**7,000**

The coverage created within this task represents a completely digital approach to isolating potential areas for groundwater exploration. The coverage can therefore be used as a guide for local water suppliers when considering future supply needs within each community. Because these datalayers were created solely through the use of digital data, field investigation would be required to confirm the presence of accessible and adequate groundwater supply.

It is important to note that an undeveloped 400-foot protective radius would be required, at a minimum, for new withdrawals. Therefore, those areas identified for potential water supply exploration that could not contain a radius of this size may not be viable options. These smaller areas were kept in the resulting shapefile, however, since future changes in adjacent land use may make these areas large enough to provide an adequate protective radius. For example, if existing agricultural areas are converted to protected open space, this change may expand the capacity of a town to provide adequate wellhead protection areas.

4.0 MAPPING INTERIM WELLHEAD PROTECTION AREAS

For this task, H&W used the refined withdrawal database to isolate those groundwater withdrawals that serve as water supplies within the subject communities. These wells were then reviewed within ArcView GIS to determine whether the required wellhead protection areas had been delineated. These areas could include both Zone 2s and IWPAs. Where these protection areas were not present, H&W planned to delineate IWPAs based on standard radius calculations determined by pumping volume. The review of the revised database and MassGIS wellhead protection areas revealed that all drinking water supply wells do have an associated Zone 2 or IWPA. Therefore, no further delineation of wellhead protection areas was performed.

5.0 PRELIMINARY WATER BUDGET ANALYSES

H&W developed preliminary water budget analyses for subwatershed areas within the larger Ten Mile/Narragansett and Mt. Hope Bay watersheds. Ten subwatershed areas (see Figure 2) were delineated using MassGIS subwatershed coverage and through communication with DCR staff. The concept of the water budget involves quantifying water inflow and water outflow within a discreet drainage area to determine if current or future water withdrawals may have adverse effects on aquifer water supply. Losses or “outflows” to aquifer water supply can be caused by well withdrawals, piping stormwater through stormdrains, or infiltration of groundwater into existing sewer lines. Gains or “inflows” to an aquifer can be caused by enhanced infiltration practices, recharge from septic systems, or natural recharge.

H&W developed the following water budgets as a preliminary assessment, anticipating future phases of study (personal communication DCR staff). These assessments, therefore, not only serve to indicate potential issues with water quantity, but also serve to identify data needs that would provide for more refined analyses. The methodology developed in this task was programmed into ArcView GIS as an interactive model. Users can enter data for recharge rates, pumping rates, and other necessary inputs to develop a report summarizing the overall water budget. In its current state, the model uses existing MassGIS data and data developed within this study as default values for conservative analyses. Where local knowledge offers more precise data, the model provides a simple graphical user interface allowing the user to input data for more refined subwatershed water budget analyses.

5.1 Information Sources and Analytical Tools

5.1.1 Commonwealth of Massachusetts Executive Office of Environmental Affairs (EOEA) Guidance for the Development of Water Budgets

EOEA Technical Assistance Bulletin #4, *Open Space and Resource Planning Guidance Document for 418 Plans* (EOEA, 2001), provides basic guidance for communities looking to develop water budgets for projected development or buildout analysis. Within the document, basic calculations are provided that account for stream flow variation, the presence of impervious surfaces, and well water withdrawal. This document was used for basic guidance purposes as well as for developing "effective impervious" area coefficients. A copy of this document is provided in Appendix A.

5.1.2 MassGIS Spatial Database and Watershed Analyst Tool

MassGIS is the agency within EOEA responsible for the generation, organization and dissemination of GIS coverage on the state level. Within the MassGIS data library are several datalayers integral to the development of the preliminary water budget. Table 9 summarizes the MassGIS datalayers used in the development of the water budget. MassGIS documentation for the development of these data, otherwise known as "metadata," is provided in Appendix G.

Table 9. MassGIS Datalayers Incorporated into the Water Budgets

Surficial Geology	Surficial geology coverage was developed on a regional level and used in this study to determine annual recharge rates. Actual recharge rates assigned to different geology types are described below.
Land Use	Land use coverage provided by MassGIS was used to refine the recharge estimates derived from surficial geology pursuant to EOEA guidance (EOEA, 2001).
Hydrography	The hydrography coverage provides a comprehensive representation of surface water and wetland features at a scale of 1:25,000.
Majors Ponds and Rivers	These datalayers cover major water features throughout the Commonwealth and were used to complement data from the Hydrography coverage.
Subwatersheds	The subwatersheds used in the study were derived from MassGIS and were modified based on personal communication with DCR staff.

Table 9. MassGIS Datalayers Incorporated into the Water Budgets (cont'd)

Massachusetts Department of Environmental Protection (DEP) Public Water Supply Data Layer	The water supply layer was used to evaluate Water Management Act (WMA) permit data.

Also included within the MassGIS Viewer is the Watershed Analyst Tool extension. This application uses the capabilities of ArcView Spatial Analyst to perform a variety of hydrologic exercises, including the automated delineation of drainage areas to a specified point in a river or stream.

5.1.3 Rhode Island Geographic Information Systems (RIGIS) Spatial Database

RIGIS is a state agency that is the Rhode Island equivalent to MassGIS, and has generated an extensive library of spatial datalayers for Rhode Island useful to the development of the preliminary water budgets. Although the inventory of datalayers is not identical as those produced by MassGIS, several layers are similar enough to be used in conjunction with MassGIS layers. The following table summarizes the datalayers that were used for the analyses. Metadata for these datalayers are included in Appendix H.

Table 10. RIGIS Datalayers Incorporated into the Water Budgets

Surficial Geology	Rhode Island surficial geology layers were merged with MassGIS data where the study area crossed the state line. These data were developed on a regional level and used to determine annual recharge rates.
Land Use	Land use coverage provided by RIGIS was merged with MassGIS data where the study area crossed the state line. These areas were used to refine the recharge estimates derived from surficial geology based on EOEA guidance (EOEA, 2001).
Major Ponds and Streams	These datalayers provide statewide coverage for surface water features throughout Rhode Island.
Wetlands	This statewide coverage was used to complement the data provided by Major Ponds and Streams by providing more comprehensive coverage of areas with no recharge.
Sewered Areas*	These datalayers were used to determine which areas of Rhode Island discharged sewage to surface water vs. those that use on-site septic systems.
RI Community Supply and Non-Community Supply Wells	These datalayers were used to locate wells within the study area and quantify potential withdrawals.

*Not available from the Commonwealth of Massachusetts. Massachusetts sewer service envelopes were digitized by H&W using maps from municipalities.

5.1.4 Water Withdrawal Database, Department of Environmental Protection, Southeast Regional Office (SERO)

DEP Southeast Regional Office maintains records of major public and private water withdrawals for the communities within this study. For security purposes, this information was not included in any of the graphics within this report. Only the digital files delivered as part of the model, which will be distributed at the discretion of DCR, contain any of this information. These withdrawals include those that are within the WMA program, and those that withdraw quantities of water less than 100,000 gallons per day. H&W communicated the data needs and the study region boundary to SERO and received a database output of known withdrawal volumes and locations. This data base was used to cross-reference data supplied by MassGIS and to add supplemental data relative to permitted withdrawal to the GIS database.

5.1.5 United States Geological Survey (USGS) STREAMSTATS Application

USGS developed a spatial model called STREAMSTATS that estimates stream-flow statistics for rivers and streams throughout most of Massachusetts. The application is interactive and works within the ArcView environment by the user clicking on a point within a visually projected stream-flow network. From the chosen point in the stream, a drainage basin is delineated using the same procedure as the Watershed Delineator Tool developed by MassGIS. The USGS application then goes further to develop a series of stream-flow statistics based on rainfall, surficial geology, slope, and data from existing stream gages. This application was used to generate stream flow statistics for comparison with results from the preliminary water budget analyses. USGS documentation of STREAMSTATS, as it appears on the website, is provided in Appendix J.

5.1.6 Annual Statistical Reports (ASRs) for Municipal Water Supply

To develop water budget analyses that reflect existing withdrawal conditions, H&W consulted ASRs for each community within the watershed areas. For the purposes of these analyses, H&W gathered three consecutive years of reporting, 2000-2002. The reports identified which withdrawals are historically active and how much water has been historically withdrawn at these sites. These reports were used to develop average annual and peak summer withdrawals volumes for use within the model. These data were attached to the withdrawal "point file" developed as part of the study.

5.1.7 Wastewater Treatment Facility Flow Records

H&W obtained wastewater treatment facility flow data from selected treatment facilities in the area. The quantity and quality of these data varied depending on the reporting capabilities of each facility. These data were used to estimate rates of groundwater infiltration into existing sewer system infrastructure within the model. A more detailed description of these calculations is provided below.

5.1.8 Wastewater and Water Supply Distribution Maps

Wastewater and water supply distribution maps were provided by each municipality in Massachusetts that contained a portion of the watershed areas within this study. For security purposes, this information was not included in any of the graphics within this report. Only the digital files delivered as part of the model, which will be distributed at the discretion of DCR, contain any of this information. These maps were provided under strict agreement and do not appear in any figures within the narrative report. Digitized versions of these areas are provided as part of the GIS model, as the model depends on these data to perform calculations. Distribution of the model and these digital data will be at the discretion of the Department of Conservation and Recreation (DCR).

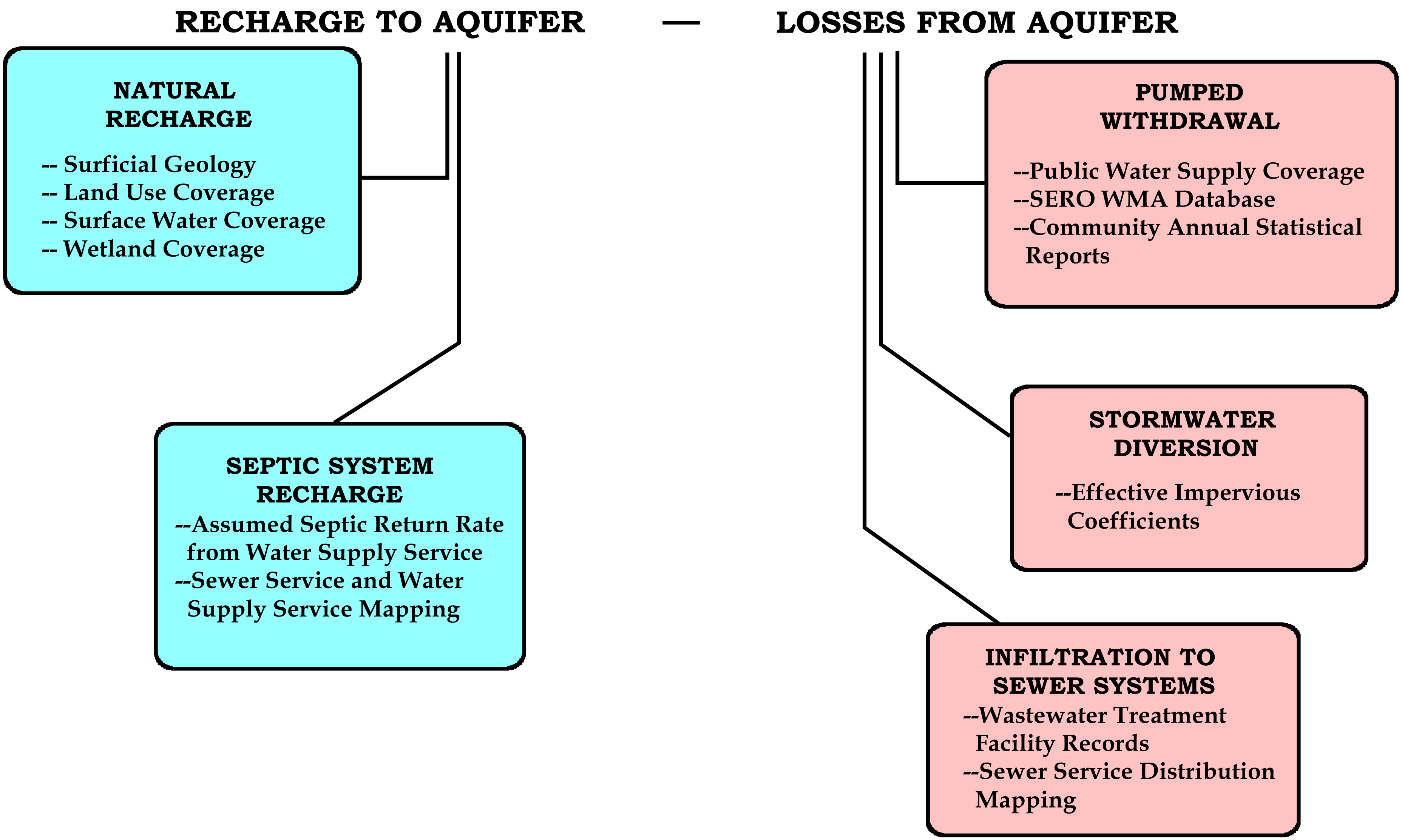
5.1.9 Personal Communication with Water Supply, Wastewater, and Environmental Professionals

H&W relied heavily upon continuous communication with a variety of professionals to refine many of the assumptions taken from conventional literature research. Local water supply and wastewater superintendents provided distribution and collection maps for the Towns within the study area to be incorporated into the GIS model. These materials, especially those for water supply distribution mapping were shared with the understanding that they are confidential in nature and would not be used for purposes outside of the scope of this project. Beyond local input, personal communication with representatives from the Massachusetts Water Resource Authority (MWRA), the United States Geological Survey (USGS), the Charles River Watershed Association (CRWA), the Massachusetts Department of Environmental Protection (MDEP), and MassGIS was integral to the development of technically sound preliminary water balances. Personal communication with these agencies is cited throughout this report.

5.2 The Conceptual Model

The water budget developed by H&W calculates the net loss or gain of water to an aquifer based on a series of impacts from water supply, wastewater management, and land use characteristics (Figure 3). The resulting loss or gain to the aquifer is then compared to selected stream flow values. Comparing these values provides an understanding of the relative impact that withdrawals are having on the aquifer under specific conditions. Through consultation with DCR, H&W developed a model that examined impacts from average annual and peak summer withdrawal conditions. In addition to these withdrawals from the aquifer, H&W also included infiltration of groundwater into sewer systems as a loss to the aquifer. Research into existing wastewater treatment plants revealed that all centralized wastewater flow from the study area represents a loss to the aquifer, either as an interbasin transfer or as a direct discharge to surface water. In each of the subwatersheds within the overall study area, calculations were incorporated into the model to account for wastewater recharge from on-site septic systems.

CONCEPTUAL MODEL



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Conceptual Model for Preliminary Water Budget

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Figure 3

Once the net loss of water during average annual and peak summer withdrawal conditions was calculated, the volume of water loss was compared to different stream flow calculations. Using guidance provided by DCR staff, H&W developed three sets of stream flow data to compare with net water loss calculations:

1. Stream flow statistics provided by the USGS STREAMSTATS application;
2. Real-time stream flow data from the Ten-Mile River stream gage; and
3. Baseflow calculations as a function of recharge from rainfall.

The baseflow calculations provided as a function of rainfall incorporate stormwater runoff quantifications through the use of "effective impervious" coefficients. These coefficients account for inflow of runoff into sewer systems and direct discharge of runoff to surface waters. A more detailed description of this approach is provided below.

The stream values provided by H&W are intended as a point of reference for potential impacts. The comparison of the modeled withdrawals against stream flow values is not intended for more sophisticated evaluations of impacts to in-stream habitat. Such sophisticated evaluations require much more refined data sets and a more narrow geographic scope to quantify seasonal reductions for individual stream reaches.

5.3 GIS Data Manipulation

GIS data used within the model included, land use, water withdrawals, surficial geology and hydrologic features. These data were gathered from disparate data sets or were developed for the project to accommodate the needs of the model. Sources of data included MassGIS, RIGIS, SERO WMA database, and printed maps.

Because several of the study subwatershed areas cross from Massachusetts into Rhode Island, two distinct sets of state GIS data were standardized for use within the model. Depending on the data set, two basic tasks were performed: spatial reprojection and/or attribute data standardization. Because the scope of this study focused on Massachusetts's communities, the data included in the MassGIS database were used as the basis for all transformation. All RIGIS datalayers were therefore made contiguous with those from MassGIS, both from the perspective of spatial display and with regard to the content of attribute tables.

Spatial reprojection within ArcView was performed using the ArcView Projection Utility Wizard extension. RIGIS provides all spatial data in North American Datum (NAD) 1983 Rhode Island Foot US, while MassGIS data are provided in NAD 1983 Massachusetts Mainland Meters. Using these coordinate systems, each of the datalayers described in Table 11 was made contiguous with MassGIS data. Where there were minute discrepancies along the borders of the State of Rhode Island (only visible at scales below 1:10), these slivers of land were deleted from the analyses. The total area of these discrepancies was insignificant.

Data conversions were performed for surficial geology and land use coverages for the study areas within Rhode Island. Land use codes were changed to match MassGIS codes using best professional judgment. Although many of the land use descriptions matched, some were slightly different. In areas of residential use, for example, the lot density categories were not identical, so qualitative judgment was used to standardize these areas. Tables 11 and 12 show the data conversions used for land use and surficial geology.

Table 11. Conversion of RIGIS Land Use to MassGIS Land Use Classifications

RIGIS Land Use Classification	Corresponding MassGIS Land Use Conversion
Residential	
111 High Density	10 Multi-Family
112 Medium-High Density	11 High-Density
113 Medium Density	12 Medium-Density
114 Medium-Low Density	12 Low-Density
115 Low Density	12 Low-Density
Commercial	
120 Commercial	15 Commercial
Industrial	
130 Industrial	16 Industrial
Transportation	
141 Roads	18 Transportation
142 Airports	18 Transportation
143 Railroads	18 Transportation
145 Active Landfills and Junkyards	19 Waste Disposal
146 Power Lines	24 Power Lines
147 Water Based Transport	32 Transport Facilities
Mixed Urban	
150 Mixed Urban	15 Commercial
Other Urban	
161 Urban Parks, Zoos, Stadiums	7 Participation Recreation
162 Urban Open Space	17 Urban Open
163 Cemeteries	34 Cemeteries
Institutional	
170 Education, Health, Correctional	31 Urban Public
Agricultural	
210 Pasture	2 Pasture
220 Cropland	1 Cropland
230 Orchards, Groves, Nurseries	21 Woody Perennial
240 Animal Farms	16 Industrial
250 Idle Agriculture	6 Open Land
Forest	
310 Deciduous Forest	3 Forest
320 Evergreen Forest	3 Forest
330 Mixed Deciduous	3 Forest
340 Mixed Evergreen	3 Forest
Brushland	
400 Brushland	21 Woody Perennial
Water	
500 Water	20 Water

Table 11. Conversion of RIGIS Land Use to MassGIS Land Use Classifications (cont'd)

Wetlands	
600 Wetlands	4 Wetlands
Barren Lands	
710 Beaches	25 Sandy Beach
720 Sandy Areas Other than Beaches	6 Open Land
730 Outcrops	6 Open Land
740 Quarries	5 Mining
750 Transitional Areas	17 Urban Open
760 Mixed Barren	6 Open Land

Table 12. Conversion of RIGIS Geology Data to MassGIS Geology Classifications

RIGIS Surficial Geology Classification	Corresponding MassGIS Surficial Geology Conversion
"Outwash"	"1 Sand & Gravel"
"Till"	"2 Till"
"Water"*	"3 Alluvium"

* Although "Water" is not technically a type of surficial geology, these areas corresponded to streambed areas and closely resembled the distribution pattern of the "Alluvium" coverage in MassGIS.

5.4 Calculation of Water Loss

5.4.1 Water Withdrawals

H&W examined all readily available data to determine the best approach to calculate water losses within each sub-basin. With regard to well location, spatial data were processed to both inventory and locate all wells within the SERO withdrawal database. These locations represent the most recent and accurate available inventory. A full inventory of wells was incorporated into the GIS as part of Task 2. With regard to existing pumping, H&W reviewed data within both the SERO WMA database and withdrawal records within municipal reports to assess the most accurate and consistent method for quantifying withdrawals.

The data associated with the withdrawal location points gathered in Task 2 of this study potentially contain two records of pumping rates: registered and permitted. Although these recorded volumes are useful for examining potential future withdrawal, they do not necessarily provide an accurate representation of which withdrawals are regularly used by municipalities and at what rates. Under actual present day conditions, it is unlikely that all wells within any of the subwatersheds would be pumping at their maximum daily pumping for a sustained period. As a result, H&W incorporated data from Annual Statistical Reports (ASRs) to develop more realistic water budget calculations. ASRs provide monthly withdrawal volumes for each withdrawal point in a municipal system.

These values were analyzed by H&W to determine the average annual and the peak summer rates of withdrawal for each withdrawal point. These values were included in the model as default values and can be changed by the user as data continue to develop.

5.4.2 Infiltration of Groundwater into Sewer Systems

Infiltration is defined as "water entering a sewer system, including sewer service connections, from the ground through such means as defective pipes, pipe joints, connections, and manhole walls" (Metcalf & Eddy, 1991). Metcalf & Eddy reports that infiltration rates can range from 100 to 10,000 gallons per day per inch of pipe width by mile of pipe length (gal/day x in-mi). The actual rates of infiltration will vary depending on the age of the system, the quality of the construction material, the quality of maintenance, and relative elevation of groundwater to the collection system (Metcalf & Eddy, 1991). H&W consulted with municipal wastewater system operators, the MWRA, and DCR to develop a reasonable approach to quantifying infiltration within the GIS environment.

Unless a complex network of meters is installed throughout a sewer system, it is difficult to develop a precise understanding of how much groundwater infiltrates into a sewer system. As infrastructure ages and wears, small leaks can appear anywhere in the system allowing for steady volumes of groundwater to seep into the pipes. It is possible, however, to develop a reasonable estimate of these infiltration rates by examining influent volumes to wastewater treatment facilities at selected times in the flow record (personal communication Vicki Gartland, DCR; personal communication Carl Leone, MWRA). Specifically, influent flow rates can be examined for the lowest service periods (2-5 AM) during dry weather conditions. In less urban areas with limited late-night commercial or industrial activity, these data can provide a reasonable estimate of groundwater infiltration rates. Focusing on periods of extended dry weather will ensure that stormwater inflow is not occurring and providing flow beyond the daily infiltration volumes.

The wastewater treatment facilities that best suited this analysis were those serving Attleboro, North Attleborough/Plainville, and Somerset. Data from these facilities were examined during low-service dry-weather periods. Data from the Fall River wastewater clearly showed significant volumes of night time flows owing to higher levels of industrial, commercial, and hospital use generally associated with more urbanized areas. These data were therefore not included in the infiltration rate calculations. Flow volumes from the remaining sewage treatment facilities were compared by dividing the estimated infiltration volume by the area of the sewer service envelope. This preliminary calculation provided a rate of flow per acre of sewer service envelope. These different values were then averaged to estimate a region-wide infiltration rate. The overall average infiltration flow was 335 gallons per day per acre of sewer envelope. This value is provided as a default in the GIS-based model, but can easily be changed if better data become available.

5.5 Calculation of Wastewater Recharge

To account for artificial recharge from wastewater, H&W used a simplified approach based on information from local water departments and an examination of wastewater mapping. The first step in this analysis was to quantify the amount of water being distributed throughout the subwatershed on a "unit area" basis. This is accomplished by evenly distributing the withdrawal volumes across the water service envelope per acre. For example, if one million gallons of water is distributed each day over 2,000 acres, the water supply envelope receives an average of 500 gallons per day per acre of service.

The second step in this calculation is to determine the acreage of the water supply envelope that will discharge through septic systems. The area serviced by septic systems was determined by overlaying the water service envelope on to the sewer system envelope. Where the water system envelope does not overlay the sewer system envelope, these areas are considered to be serviced by septic systems. Once this area was calculated, the acreage was multiplied by the volume of water received per acre. Following the example above, if the water supply system delivers 500 gallons per day per acre, and 100 acres are serviced by septic systems, then 50,000 gallons of water per day is delivered to areas serviced by septic systems.

The final step in calculating the return of water through septic systems is to multiply the total volume of water delivered to the septic area by an assumed reduction due to consumption. Consumptive loss within these subwatersheds occurs primarily as actual drinking water consumption and lawn irrigation, although other domestic activities such as car washing and filling swimming pools will account for some consumptive loss in residential areas. In these areas, a wastewater recharge return rate of 85% (Horn, 2000) was applied. In other words, 85% of the water distributed to these areas was assumed to return to groundwater via septic systems. Following with the above example, if 50,000 gallons of water is delivered each day to areas serviced by septic system, these areas are recharging 42,500 gallons per day to the aquifer.

5.6 Calculation of Stream Flow

5.6.1 Stream Flow as a Function of Recharge to Groundwater

The most consistent component of stream flow is baseflow, which is derived from groundwater discharge. Water from rainfall or wastewater discharge that recharges to groundwater provides a steady supply of water discharge to rivers and streams, and often ensures continuous flow during ecologically critical drought conditions. Accordingly, H&W performed baseflow calculations for each subwatershed using the digital data in the GIS. The results of these calculations provide reasonable estimates of average flow conditions in dry weather throughout the year and were compared with average annual withdrawal scenarios developed in the model.

To quantify recharge from rainfall on an annual basis, H&W used a composite of digital datalayers from MassGIS and RIGIS (see Tables 11 and 12). The spatial data in these files were processed within the model to first eliminate those areas assumed to provide no recharge, such as surface water bodies. Once these areas were eliminated, the model assigned a recharge rate to the remaining areas based upon the combined land use/surficial geology characteristics. Where surficial geology is found to be sand & gravel, a base recharge rate of 24 inches per year is used (Hansen et al., 1992). Where surficial geology is till, a base recharge rate of 8 inches per year is applied (Mazzafferro et al, 1979; Melvin et al, 1992; Morrissey, 1983; Olimpio et al., 1984; Starn et al., 2000). These recharge rates are used as default values within the model and can be changed by the user if local knowledge indicates that different values are more appropriate.

5.6.2 Adjusting Recharge Rates to Account for Stormwater Runoff

The base recharge rates selected for the model were modified to account for land use by using fixed percentages adapted from the EOEA guidance (EOEA, 2001) and recent literature. These adjustments were made for "effective impervious" cover. Effective impervious cover represents the percentage of overall impervious area that precludes rainfall from becoming recharge. Effective impervious areas are most commonly those that route stormwater directly to receiving water bodies or into stormdrain systems. EOEA (2001) provides rates of "effective imperviousness" associated with the land use categories found within the MassGIS database.

H&W used these rates in conjunction with other studies (Capiella et al., 2001; Zariello, 2000) and communications with hydrology professionals (personal communication, Nigel Pickering CRWA) to develop an adjustment coefficient for each impervious percentage applied to land use codes. For example, the effective impervious coefficient for commercial land use is 63%. Therefore, the model would reduce the recharge rate of a commercial property on sand and gravel by 63% (24 inches per year to 8.9 inches per year). Table 13 summarizes the effective impervious coefficients adapted from EOEA Technical Bulletin #4 (EOEA, 2001) and other sources. It is important to note that, in some developed areas, stormwater recharge can actually be increased depending on the runoff management strategies implemented on specific sites. The reductions applied to specific land use areas in this study, therefore, represent averages across the region.

Table 13. Summary of Stormwater Adjustment Factors for Land Use Categories

Land Use Category*	Reduction Percentage Applied to Recharge	Source
Participation Recreation	1	EOEA, 2001
Spectator Recreation	2	EOEA, 2001
Water-Based Recreation	1	EOEA, 2001
Multi-Family Residential	64	Zariello et al., 2000
High-Density Residential	11.2	Capiella et al., 2001
Medium-Density Residential	2.5	Zariello et al., 2000
Low-Density Residential	2.5	Zariello et al., 2000
Commercial	63	Zariello et al., 2000
Industrial	71	EOEA, 2001
Transportation	71	EOEA, 2001
Waste Disposal	1	EOEA, 2001
Saltwater Sandy Beach	1	EOEA, 2001
Golf	1	EOEA, 2001
Marina	71	EOEA, 2001

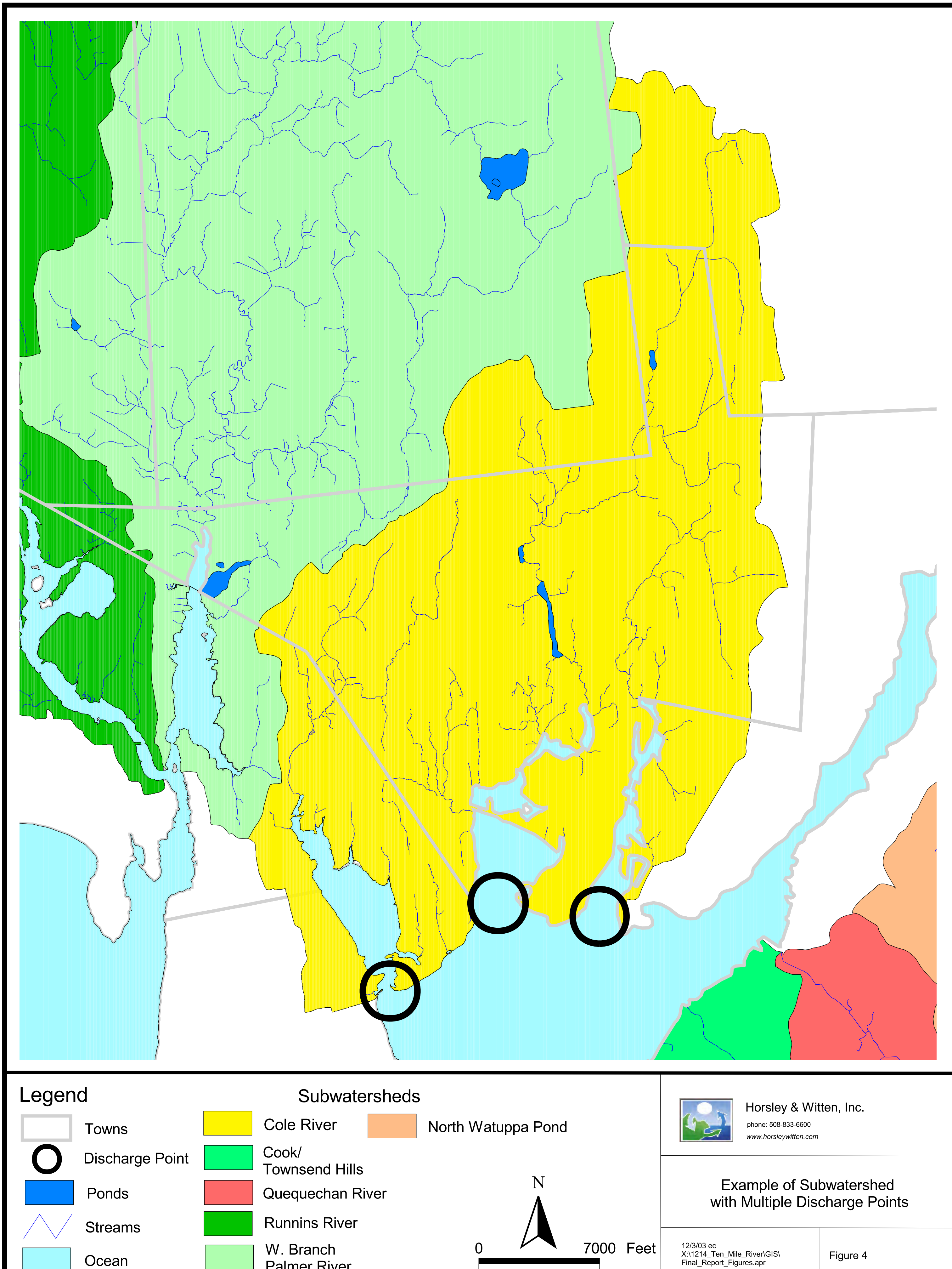
*Only those land use categories that have a reduction coefficient are listed in the above table. All other categories within the MassGIS database have no reduction coefficients.

Once all recharge rates are adjusted according to effective impervious cover, the cumulative baseflow is calculated by multiplying that rate of recharge by the area of each land use within the subwatershed. The model developed for this study performs these calculations once the user has provided the appropriate base recharge rates for sand & gravel, glacial till, and wetland areas.

5.6.3 Stream Flow from the USGS STREAMSTATS Application

H&W used the USGS STREAMSTATS application to develop a series of stream flow data for each subwatershed. The purpose of using this application within the water budget was to provide flow statistics to compare with both the average annual and peak summer withdrawal scenarios. The application works in GIS by calculating stream flow statistics from a specified point on a centerline network provided for all of the surface waters within the three watersheds. H&W selected those points on the centerline network that best represented ultimate discharge of flow from each of the subwatershed areas. Where a subwatershed in the study has more than one major discharge point (e.g. the Cole River), STREAMSTATS was run for each discreet discharge point, and the results were added together to calculate the aggregate stream flow for the entire drainage area (Figure 4).

STREAMSTATS calculates a wide range of statistics for each point chosen by the user ranging from the 99^{th} to 50^{th} percentile exceedance flow, and including the 7Q10, 7Q2, and August median stream flow. All results are reported in cubic feet per second (cfs). The amount that was chosen to best represent average annual flow was the 50^{th} percentile exceedance flow.



Example of Subwatershed
with Multiple Discharge Points

Figure 4

The amounts chosen to best represent summer conditions were the 90th percentile exceedance (dry conditions) and the 98th percentile exceedance (extreme drought conditions) (personal communication, Fletcher Pyle formerly of MA DEM Water Resources Division).

5.6.4 Stream Flow Statistics Developed by Prorating Existing Data

A daily stream flow gage is located on the Ten Mile River close to its discharge point in Pawtucket, Rhode Island (USGS #01109403). This station measures flow within the subwatershed area designated "Upper Ten Mile River" for the purposes of this study. The data record used for these calculations, downloaded from the Internet, covers the period from October, 1986 through September, 2001.

Following the STREAMSTATS approach described above, H&W calculated three separate stream flow statistics from this record: the 50th percentile, 90th percentile, and 98th percentile exceedance flows. These values were chosen to best represent average annual conditions (50th percentile exceedance) and drought conditions (90th and 98th percentile exceedance).

Under DCR guidance, the three statistics developed from the Ten Mile River gage were pro-rated to each of the other subwatersheds in the study as a function of the ratio of the watershed areas. For example, if the Bungay River subwatershed were exactly half the size of the Ten Mile River subwatershed, the Ten Mile River statistics were multiplied by 0.5 to calculate Bungay River values. This exercise assumes that each subwatershed in the region has similar overall hydrogeologic profiles, and, therefore, each stream responds similarly to both seasonal and wet weather conditions. Each of these values is provided as a comparison to the overall water loss in each subwatershed to gage the relative impacts from different withdrawal scenarios.

5.7 Results of Preliminary Water Balance Calculations

5.7.1 Summary of Stream Flow Analyses

The stream flow analyses performed for each of the subwatershed analyses were designed to provide a variety of stream flow values with which to compare losses to the aquifer. While a complete analysis of the value of these different stream flow calculations was outside the scope of this report, some general observations were made.

The values provided in the prorated flow analysis represent adjustments to actual stream flow values recorded on the Ten Mile River. As such, these values theoretically incorporate impacts from development such as well withdrawals, flows provided by wastewater treatment facility outfalls, and impacts from impervious cover. Comparing the modeled loss to the aquifer to these flows is therefore, in a sense, a circular exercise. However, the comparison is still valuable for examining the relative impact of aquifer loss within the overall flow regime. The loss or gain to the aquifer, when examined as a percent of the existing flow exceedances, provides a sense of how sensitive these systems will be to potential future changes. For example, where the loss to the aquifer represents a significant percentage of the prorated flow, future reductions in withdrawal could significantly increase the relative flow in either average annual or peak summer conditions.

The baseflow values provided as a function of rainfall are calculated within the model for each discreet drainage area. It is important to realize that, in two instances, upgradient subwatersheds are flowing into downstream subwatersheds. The Bungay River, Coles Brook, and Seven Mile River all flow into the Upper Ten Mile River. Also, the North Watuppa Pond subwatershed contributes to the Quequechan River subwatershed. The baseflow values calculated for these subwatershed areas are reported as both discreet baseflows and aggregate baseflows in the results tables below. Table 14 summarizes the different flow calculations performed for comparison with calculated losses to the aquifer systems.

It should be noted that baseflow calculations incorporate losses to the aquifer from impervious surface development. In developed areas, losses to the aquifer are assumed as a specific percentage of impervious area. These areas are modeled as if stormwater runoff is routed to sewer systems or directly to receiving water bodies. As a result, developed subwatersheds experience significant losses to aquifer recharge over the course of the year. Table 15 compares the baseflow calculations provided by the model and calculations for undeveloped conditions.

Table 14. Calculated Stream Flow Values Summary (reported in cfs)

SUBWATERSHED	STREAMSTATS (percentile exceedance)			Prorated Daily Stream Flow (percentile exceedance)			Baseflow (discreet drainage area)	Baseflow (aggregate drainage area)
	98th	90th	50th	98th	90th	50th	Calculated as Recharge	
Bungay River	0.4	1.9	7.4	3.8	5.9	17.8	9.0	
Cole River	1.4	3.6	32.3	15.3	23.9	72.7	28.2	
Coles Brook	0.1	0.2	3.3	1.6	2.5	7.5	2.4	
Cook/Townsend Hills	0.1	0.3	1.9	2.7	4.1	12.6	3.6	
North Watuppa Pond	0.7	1.7	11.3	5.7	8.9	27.0	11.4	
Quequechan River	1.4	3.7	30.7	9.5	14.8	45.0	17.3	28.7
Runnins River	0.6	1.4	10.0	7.2	11.3	34.2	16.4	
Seven Mile River	0.6	1.6	12.6	6.2	9.6	29.3	11.8	
Upper Ten Mile River	3.8*	9.2*	54.6*	16.0	25.0	76.0	35.4*	58.5*
West Branch Palmer River	2.2	5.6	80.5	25.5	39.8	121.0	54.5	

*These values do not account for the flow from the North Attleborough Wastewater Treatment Facility, which discharges directly to the Upper Ten-Mile River. The average daily flow from this facility is approximately 4.33 mgd or 6.7 cfs.

Table 15. Loss of Baseflow Due to Impervious Cover/Stormwater Diversion

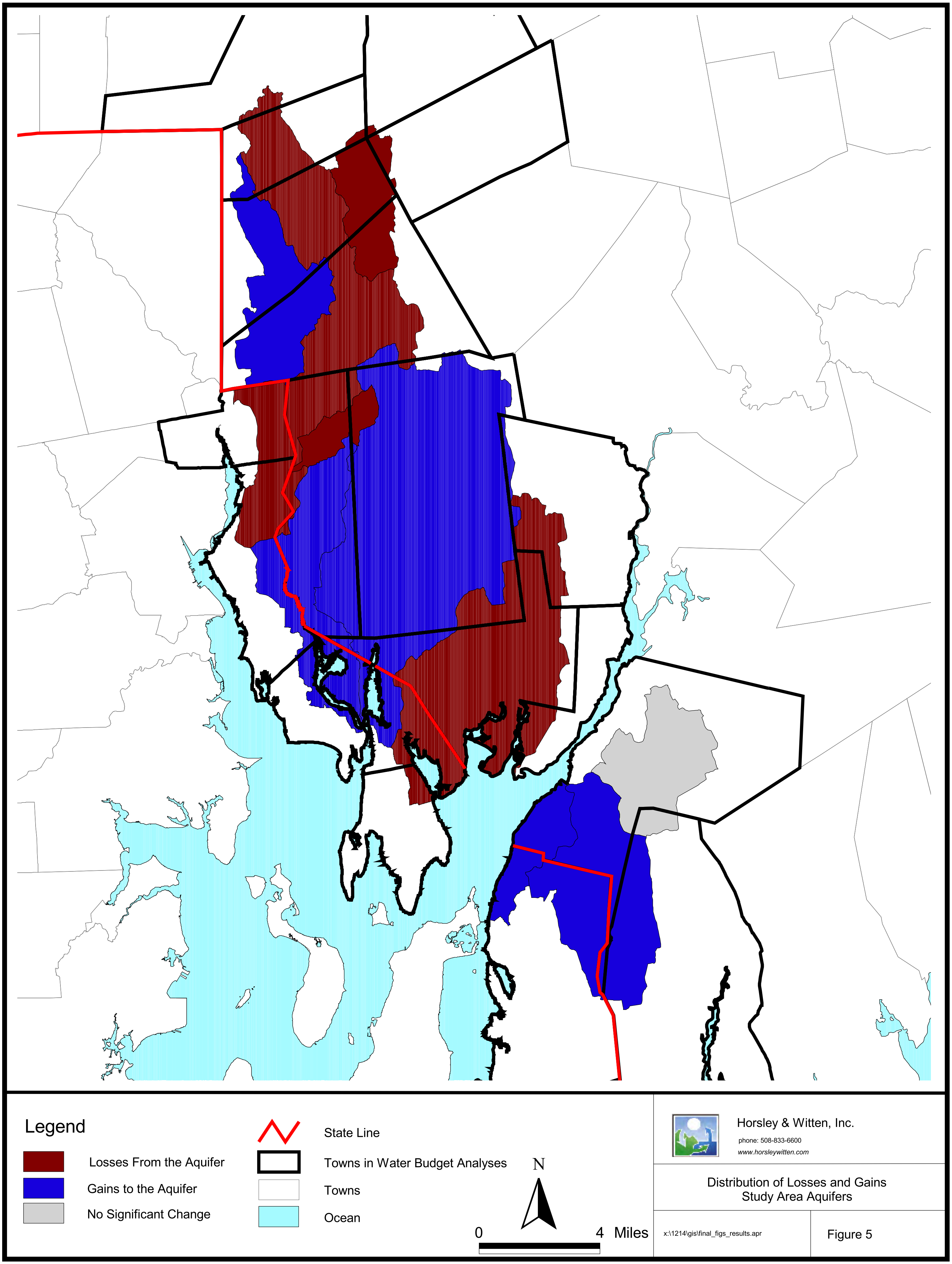
Subwatershed	Calculated Baseflow (Existing Conditions)	Calculated Baseflow (Pre-Development Conditions)	Loss of Baseflow from Impervious Cover
Bungay River	9.0	9.7	0.7
Cole River	28.2	29.5	1.3
Coles Brook	2.4	2.4	0.0
Cook/Townsend Hills	3.6	4.6	1.0
North Watuppa Pond	6.8	7.1	0.3
Quequechan River	18.9	20.7	1.8
Runnins River	16.4	18.3	1.9
Seven Mile River	11.8	12.8	1.0
Upper Ten Mile River	58.5	66.3	7.8
West Branch Palmer River	54.5	55.9	1.4

5.7.2 Summary of Average Annual Withdrawal Analyses

Net losses of water to the aquifer within each subwatershed were calculated for average annual withdrawal conditions pursuant to DCR guidance. Elements of the calculations include losses from withdrawal and infiltration of groundwater into sewer systems as well as returning volumes from septic system discharge. Figure 5 shows the distribution of "gaining" versus "losing" aquifers across the study area. The results of average annual analyses are shown in Table 16. The comparison of these water budget calculations to stream flow values is shown in Table 17.

Table 16. Results of Preliminary Water Budget Analyses Under Average Annual Withdrawal and Stream Flow Conditions (values reported in cfs)

Subwatershed	Withdrawal Volume (cfs)	Infiltration to Sewer Systems (cfs)	Return Through Septic Systems (cfs)	Net Gain/Loss (cfs)
Bungay River	1.3	0.0	0.5	-0.7
Coles Brook	0.5	0.0	0.2	-0.2
Cole River	5.9	0.0	4.2	-1.7
Cook/Townsend Hills	0.0	0.0	0.4	+0.4
North Watuppa Pond	0.0	0.0	0.0	0.0
Quequechan River	0.0	0.0	0.2	+0.2
Runnins River	0.0	0.0	0.9	+0.9
Seven Mile River	0.0	0.0	1.0	+1.0
Upper Ten Mile River	3.3	0.0	1.2	-2.2
West Branch Palmer River	0.8	0.0	1.3	+0.5



Distribution of Losses and Gains
Study Area Aquifers

Figure 5

Table 17. Comparison of Modeled Loss to Aquifer in "Average Annual" Scenarios

SUBWATERSHED		STREAMSTATS		Prorated Daily Stream Flow		Baseflow from Recharge	
	Calculated Gain/Loss to Aquifer (cfs)	50th percentile (cfs)	percent change	50th percentile (cfs)	percent change	Baseflow (cfs)	percent change
Bungay River	-0.7	7.4	-9.7%	17.8	-4.0%	9.0	-8.0%
Cole River	-1.7	32.3	-5.1%	72.7	-2.3%	28.2	-6.0%
Coles Brook	-0.2	3.3	-7.3%	7.5	-3.2%	2.4	-10.0%
Cook/Townsend Hills	+0.4	1.9	+19.4%	12.6	+3.0%	3.6	+10.2%
North Watuppa Pond	0.0	11.3	0.0%	27.0	0.0%	11.4	0.0%
Quequechan River	+0.2	30.7	+0.7%	45.0	+0.4%	28.7	0.0%
Runnins River	+0.9	10.0	+8.8%	34.2	+2.6%	16.4	+5.3%
Seven Mile River	+1.0	12.6	+7.5%	29.3	+3.2%	11.8	+8.1%
Upper Ten Mile River	-2.2	54.6	-4.0%	76.0	-3.0%	58.5	-3.8%
West Branch Palmer River	+0.5	80.5	+0.6%	121.0	+0.4%	54.5	+0.9%

5.7.3 Summary of Peak Summer Withdrawal Analyses

Calculations for peak summer withdrawal volumes were performed to assess impacts to aquifer systems when drought conditions are common, water consumption is at it highest, and recharge is critical to sustaining stream flow as water table elevations drop. Table 18 summarizes the results of the peak summer withdrawals and the net loss to each aquifer within the study area. Table 19 summarizes the comparison of these gains and losses to stream flow values.

Table 18. Results of Preliminary Water Budget Analyses Under Peak Summer Withdrawal and Stream Flow Conditions (values reported in cfs)

Subwatershed	Withdrawal Volume	Infiltration to Sewer Systems	Return Through Septic Systems	Net Gain/Loss
Bungay River	1.84	0.00	0.67	-1.17
Coles Brook	0.91	0.00	0.37	-0.54
Cole River	8.49	0.00	5.90	-2.59
Cook/Townsend Hills	0.00	0.00	0.40	+0.40
North Watuppa Pond	0.00	0.00	0.00	0.00
Quequechan River	0.00	0.00	0.21	+0.21
Runnins River	0.00	0.01	1.45	+1.46
Seven Mile River	0.00	0.00	1.19	+1.19
Upper Ten Mile River	5.64	0.02	1.66	-4.00
West Branch Palmer River	1.06	0.00	1.97	+0.91

Table 19. Comparison of Modeled Loss to Aquifer in "Peak Summer" Scenarios

		STREAMSTATS				Prorated Daily Stream Flow			
SUBWATERSHED	Calculated Gain/Loss to Aquifer (cfs)	90th percentile (cfs)	percent change	98th percentile (cfs)	percent change	90th percentile (cfs)	percent change	98th percentile (cfs)	percent change
Bungay River	-1.2	1.2	-99.2%	0.44	-266.0%	5.86	-20.1%	3.75	-31.2%
Cole River	-2.6	3.62	-72.0%	1.36	-190.4%	23.92	-11.0%	15.31	-17.0%
Coles Brook	-0.54	0.22	-245.4%	0.08	-675.0%	2.46	-22.1%	1.57	-34.4%
Cook/Townsend Hills	+0.40	0.29	+138.0%	0.10	+400.0%	4.14	+10.1%	2.65	+15.1%
North Watuppa Pond	0.00	1.70	0.0%	0.65	0.0%	8.89	0.0%	5.69	0.0%
Quequechan River	+0.21	3.67	+6.0%	1.36	+15.4%	14.79	+1.4%	9.47	+2.2%
Runnins River	+1.46	1.43	+102.1%	0.54	+270.4%	11.25	+13.1%	7.2	+20.3%
Seven Mile River	+1.19	1.57	+76.1%	0.60	+198.3%	9.64	+12.3%	6.17	+19.3%
Upper Ten Mile River	-4.00	9.15	-44.0%	3.76	-106.4%	25.00	-16.0%	16.00	-25.0%
West Branch Palmer River	+0.91	5.59	+16.3%	2.20	+41.4%	39.80	+2.2%	25.47	+4.1%

5.8 Discussion of Results

5.8.1 General Observations

The results of the modeling demonstrate that four of the subwatersheds experience losses to the aquifer in both average annual and peak summer withdrawal conditions. These subwatersheds include those for the Bungay River, Cole River, Coles Brook and Upper Ten Mile River. The municipal water supplies that consume water from these aquifers include Plainville, North Attleborough, Attleboro, Dighton, and Swansea.

The determining factors for water loss to the Upper Ten Mile and Bungay River aquifers include a mix of significant withdrawals from groundwater wells and disposal of wastewater through centralized sewage treatment facilities. As mentioned earlier in the report, all wastewater treatment facilities serving these municipalities either transport wastewater out of the study area or discharge sewage effluent directly to surface waters through outfalls. In either case, centralized wastewater disposal represents a loss to the aquifer. For example, 2,352 acres of the Bungay River subwatershed are covered in either the Plainville/North Attleborough sewer service envelope, 49% of the entire watershed area. The Upper Ten Mile River, also, is predominantly serviced by municipal sewer systems, with the service envelope covering 62% of the drainage area. The extent of sewer system service in these subwatershed areas creates a situation where only a small portion of the water use in the area can return to the aquifer through on-site septic systems.

With regard to Coles Brook and the Cole River, neither aquifer system experiences significant losses through the use of centralized wastewater treatment, although the Cole River does contain a portion of the Somerset wastewater treatment service envelope. In both cases, the subwatersheds experience a significant level of annual and peak summer withdrawal relative to their annual recharge volumes. Wells within the Cole River subwatershed, for example, withdraw water at an average rate of 5.88 cfs over the year. Once consumptive loss and septic recharge are accounted for, this rate of withdrawal creates a loss of 1.65 cfs to the aquifer, approximately 6% of the baseflow calculated as a function of recharge. In peak summer conditions, the aquifer experiences a loss of approximately 2.59 cfs, or 11% of the 90th percentile exceedance flow as calculated by prorating existing stream flow data (see section 5.6.4 for explanation of prorating stream flow data from one subwatershed to another). Wells in the Coles Brook subwatershed cause smaller volumes of loss for average annual and peak summer conditions when compared to the Cole River. Losses to this small aquifer system during average annual conditions amount to 0.24 cfs and, during periods of peak demand, 0.54 cfs. However, when compared to the stream flow statistics generated for this basin, these small losses represent a more significant percentage of the overall budget because of the small drainage area. When compared to the baseflow and the 90th percentile exceedance stream flow, the percentages of loss during average annual and peak summer conditions are 10.0% and 22.1% respectively.

Peak summer analyses were compared to the 90th percentile and 98th percentile exceedance flows to observe withdrawal impacts against stream flow during drought conditions. In those cases where subwatersheds are losing water, summer withdrawals represent a significant portion of the projected flow, even under the least conservative comparison. Water losses to the aquifer represent anywhere from 11.0% to 22.1% of the projected stream flow, when examining the 90th percentile exceedance for the prorated stream flow statistics. Comparisons to 98th percentile exceedance flows show that losses to the aquifer actually exceed the predicted flow by up to 675%. In these instances, stream flows my actually dry up for certain periods.

For the large drainage areas such as the Cole River, the lag time for groundwater recharge to become stream flow may be long enough that the impacts of these peak summer withdrawals are minimized. The overall groundwater system may equilibrate over time, allowing for a reasonably steady supply of recharge during drought conditions. In smaller drainage areas such as the Coles Brook, however, withdrawals may impact the stream flow more significantly due to a shorter lag time between groundwater recharge becoming stream flow recharge. This smaller subwatershed may respond more quickly to significant withdrawals and could experience significant reductions in stream flow during the high water demands of the summer.

In general, those subwatersheds served by surface water supplies and on-site septic systems experienced lower volumes of loss or even small gains to the underlying aquifers. The most obvious reason for lower levels of loss within a subwatershed area is the presence of on-site septic systems. For example, the West Branch Palmer River subwatershed is almost entirely serviced with on-site systems and therefore experiences a regular recharge of wastewater to the aquifer across almost the entire drainage area.

In cases where subwatersheds actually show more water recharging the aquifer than leaving the system, these subwatersheds are the beneficiaries of interbasin transfer. Interbasin transfer is common throughout the study area as individual withdrawals can distribute water across a municipality and, consequently, across one or more subwatershed boundaries. Where a municipality uses centralized wastewater treatment, interbasin transfer represents a loss from the aquifer since the wastewater effluent is discharged through outfalls to surface water. However, where wastewater is discharged through on-site septic systems, these systems are often discharging wastewater that originated as groundwater from a separate drainage area. For example, the Town of Seekonk relies on well withdrawals for water supply and on-site septic systems to dispose of wastewater. Most of the Town's water is withdrawn from the Newman well field, which lies in both the Coles Brook and Upper Ten Mile subwatersheds. As this water is distributed across the Town for consumption, septic systems within the Runnins River and West Branch Palmer River subwatersheds will recharge wastewater that originated in the Coles Brook and Upper Ten Mile subwatersheds.

5.8.2 Comparing the Results of the Water Needs Forecasting with the Preliminary Water Budget Analyses

In Task 1 of this report, five communities were identified as needing higher permitted withdrawal levels based on future population projections. These communities include Attleboro, Fall River, Mansfield, North Attleborough, and Seekonk. The following table (Table 20) summarizes the subwatersheds contained in each of these towns and whether the subwatersheds showed a gain or loss in the preliminary water budget analyses.

Table 20. Gain or Loss of Water in Each Aquifer by Municipality

Community	Subwatershed	Gain or Loss of Water to the Aquifer
Attleboro	Bungay River	Loss
	Upper Ten Mile River	Loss
	Seven Mile River	Gain
Fall River	North Watuppa Pond	No Change
	Quequechan River	Gain
	Cooks/Townsend Hills	Gain
Mansfield*	Bungay River	Loss
North Attleborough	Bungay River	Loss
	Upper Ten Mile	Loss
	Seven Mile River	Gain
Seekonk	Upper Ten Mile	Loss
	Coles Brook	Loss
	Runnins River	Gain
	West Branch Palmer River	Gain

* The majority of Mansfield lies outside of the subwatersheds examined in this study. Further study would have to be performed to determine how the majority of drainage areas within this municipality perform with regard to water budget analysis.

Each of the municipalities identified in Task 1 as requiring greater permitted volumes of water, with the exception of Mansfield, show at least one aquifer area that did not show a loss within the preliminary water budget analyses. This table can therefore be used to potentially identify those withdrawals where a municipality should look to increase permitted volumes in the future. Table 21 identifies the withdrawals that lie within subwatersheds where no loss of water was identified in water budget analysis.

Table 21. Existing Withdrawals in Unstressed Aquifers for Municipalities That Will Require Greater Volumes of Permitted Withdrawal

Municipality	Subwatershed (no loss to aquifer)	Existing Municipal Supply Withdrawals
Attleboro	Seven Mile River	Orr's Pond
Fall River	North Watuppa Pond	North Watuppa Pond
	Quequechan River	none
	Cooks/Townsend Hills	none
North Attleborough	Seven Mile River	none
Seekonk	Runnins River	none
	West Branch Palmer River	none

Table 21 shows that it may be possible for the City of Attleboro and The City of Fall River to increase permitted volumes of water withdrawal without causing significant stress to the underlying aquifer systems. In Attleboro, the Orr's Pond well withdraws from the Seven Mile River aquifer, which shows a gain of 0.95 cfs on an average annual basis. This gain in recharge results primarily from the use of on-site septic systems throughout much of the Seven Mile River subwatershed. In Fall River, the city relies almost exclusively on the use of surface water supply and therefore does not tax the underlying aquifer in either average annual or peak summer conditions.

Table 21 shows that North Attleborough and Seekonk may have difficulty increasing permitted withdrawals from existing wells without further stressing the aquifers within the municipal boundaries. Neither municipality has an established supply well within a subwatershed that does not show loss within the preliminary water budget analyses.

5.8.3 Comparing the Identification of Areas for Future Water Source Exploration with the Preliminary Water Budget Analyses

Under Task 4, potential areas for future water supply exploration were identified using a series of GIS data layers that represented "opportunities" and "constraints". The resulting areas for potential future exploration are depicted in Appendix I. The aggregates of these areas by municipality are provided in Table 8. H&W looked at those areas identified for potential future exploration in the context of the preliminary water budget analyses to evaluate the viability of those areas that lie within the study subwatersheds. Table 22 summarizes the areas for potential exploration for each municipality and subwatershed, assuming that no exploration would occur in subwatersheds showing a loss in the preliminary water budget analyses.

Table 22. Acreage for Potential Water Supply Exploration in Unstressed Aquifers

Municipality	Subwatersheds within Study Area not Showing a Loss to the Aquifer	Area for Potential Water Supply Exploration (acres)
Attleboro	Seven Mile River	0.0
Dighton	West Branch Palmer River	0.0
Fall River	North Watuppa Pond	20.4
	Quequechan River	0.0
	Cooks/Townsend Hills	0.0
Foxborough	none	0.0
Mansfield	none	0.0
North Attleborough	Seven Mile River	0.0
Plainville	none	0.0
Rehoboth	Runnins River	0.0
	West Branch Palmer River	1,569.9
Seekonk	Runnins River	180.3
	West Branch Palmer River	47.9
Somerset	none	0.0
Swansea	Runnins River	20.9
	West Branch Palmer	318.2
Wrentham	none	0.0

5.9 Recommendations For Further Study

5.9.1 Withdrawal Locations

The location coordinates associated with three withdrawals inventoried as part of Task 2 were incorrect: North Attleboro National Fishery, Morse Brothers, Inc. (Foxboro), Byrne Sand and Gravel (Foxboro). Although using other information associated with these wells, such as the address or associated use, can give a reasonable corrected location, we recommend that these withdrawal locations be verified using a GPS unit. Field-checking these withdrawals in this manner will ensure that their location within the water budget is accurate.

5.9.2 Recharge Through Septic Systems

H&W employed a simplified approach to calculating the rate of wastewater return for all communities within the study area. For those communities served by a mixture of septic and sewer systems, the number of sewer connections was divided into the number of water bills to estimate the overall rate of return throughout the community. This approach provides a reasonable estimate but does not account for large-scale individual users that may serve to skew the overall amount of water discharged through either septic systems or sewer. A more precise meter-by-meter approach to calculating the relative discharge from septic versus sewer systems would serve to refine the default calculations offered as part of the existing model structure.

5.9.3 Distribution of Water Supply

The best available data from local suppliers regarding water supply included maps of the water distribution system and ASR water withdrawal summaries. H&W distributed the aggregate amount of withdrawn water across the entirety of the water distribution envelope to calculate an average distribution of water across the municipality. This approach has limitations in that it does not account for sparsely populated areas or areas of higher water use. Existing mapping was not consistent in a manner that allowed for developing a more detailed spatial approach in each of the municipalities. Further, where a Town used multiple withdrawals, these points are tied in to a single distribution system. Existing mapping does not show which area of the distribution systems are serviced by individual withdrawal points. In reality, a specific area of a community may be served by different withdrawal points depending on seasonal considerations or maintenance issues. Further research could divide the water service envelopes digitized by H&W by intensity of use and could potentially tie specific service areas to specific wells.

5.9.4 Pumping Rates for Private Wells

The subwatersheds throughout the overall study area contain many private wells. Although it was not within the scope of this study to quantify impacts from these wells, there are subwatersheds where this information could enhance the analysis. For example, the majority of the West Branch Palmer River lies within the Town of Rehoboth. Rehoboth does not have a public water supply and therefore obtains water from individual private wells. The withdrawal volumes in these wells were not included in the model. Preliminary results show that the West Branch Palmer River aquifer is actually gaining water from other municipal water supplies in Massachusetts and Rhode Island through septic discharge. These gains would likely be offset, to some degree, by the private well usage in Rehoboth. The amount of this offset could be quantified within the model if average annual and peak summer withdrawal rates were gathered for the private supply wells in the area.

5.9.5 Analysis of Well Withdrawal on Stream Flow Based on Proximity of Wellheads to Streams

H&W developed a comparative analysis that assumes stream flow will be potentially impacted by each withdrawal in a subwatershed. This assumption ignores the relative size of subwatersheds and the distance from wellheads to actual stream bodies. A more refined analysis can incorporate calculations for “near-field” and “far-field” wells.

Near-field wells describe those wellheads that are situated in the sand and gravel deposits adjacent to streambeds. In Southeast Massachusetts, these deposits are common and can provide areas of high pumping yields ideally suited to public supply. Under these conditions, however, stream flow will respond instantaneously to pumping activity, resulting in reduced flows. Far-field wells, depending on their pumping rates, can have more indirect impacts on stream flow, or no impact at all. A more sophisticated withdrawal analysis would account for the lag time between far-field withdrawals and impacts to distant stream flows.

5.9.6 Effective Impervious Surface Coefficient Calibration

Effective impervious coefficients were used to adjust natural recharge rates on developed land use areas. These rates were adapted from research within the Commonwealth of Massachusetts or from EOEA Guidance (EOEA, 2000). Because the Upper Ten Mile River has an existing stream flow gage, it would be possible to calibrate these coefficients to existing stream flow values.

The calculated aggregate baseflow for the Upper Ten Mile subwatershed is 58.5 cfs. The 50^{th} percentile exceedance flow derived from the stream flow record is 76.0 cfs. This discrepancy suggests that the effective impervious coefficients may be too high. The values within the report may be creating a scenario where more stormwater is being directed away from recharge than what is taking place in existing conditions. In some cases, impervious cover may actually increase recharge levels depending upon the stormwater management techniques applied to specific developments. A survey of existing stormwater management practices throughout the subwatershed could provide a better understanding of stormwater pathways and could be used to reduce effective impervious coefficients for existing land use categories.

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APPENDIX A

Generic Water Needs Forecast Methodology

Massachusetts Water Resources Commission

River Basin Planning Program
Generic Water Needs Forecast Methodology

Municipal Water Needs Forecast

The methodology for forecasting public water supply needs for each basin uses a disaggregated approach, based on the most recent three to five years' water use (called Base Demand) for each community in the study area. The three main water use categories for each community are residential, non-residential (including commercial, industrial, agricultural, municipal), and unaccounted-for water (UAW).

The main assumptions of the disaggregated approach and the calculations used to arrive at the disaggregated 20-year forecast shown are detailed below.

"Method 1", shown in Table 1, is used to arrive at water use forecasts for those communities which

- ☐ are able to provide sufficient disaggregated water use data
- ☐ show a residential gallons per capita daily use (gpcd) of 80 or less
- ☐ have an unaccounted-for water factor of 15% or less

For communities that have insufficient data to develop a disaggregated water needs forecast, have a residential gpcd over 80, or a high percentage of unaccounted-for water, Method #2, shown in Table 2, has been used.

Disaggregated Water Needs Forecast - Method #1

1. Columns A through G show most recent census estimate and Base municipal water use data (base average day demand). Column D, seasonal population factor was calculated by multiplying the summer population by 3 (for the 3 summer months), dividing this number by 12 (for the year). Column E, the base service population, is calculated by multiplying Column A, the current population estimate by Column B, the percent of the population served by the water supplier, then adding Column C, the out of town population and Column D, the seasonal population factor, to this product. Column F, base ADD shows the average of the average day demand of the most recent three to five year water use. The water demand information was obtained from the water supplier for each community and from Department of Environmental Protection (DEP). Column G, base gpcd is calculated by dividing column G, base ADD by column E, base service population.

2. Columns H through J show the residential portion of the base average day demand (ADD). The percentage of residential water use is shown in column H. The residential gpcd, shown in column I, is calculated by dividing column J, residental ADD by column E, base service population.

3. Columns K and L, non-residential water use, are based on information provided by the community or DEP.

4. Columns M and N, unaccounted-for water (UAW), are obtained by subtracting the residential and non-residential water use from the total water use in F; thus N=(F-[J+L]). UAW consists of

leakage, and unmetered use, especially public unmetered use. The data were obtained either from DEP statistical sheets or from personal interviews with the water supplier for each community.

5. Columns P through R show how residential water use is projected to change through the end date. The projected service population, column R, is calculated from the population projection, column P, and the estimated increase percentage of the population served in the future, column Q. The future service population is multiplied by the existing residential gpcd, column I, to obtain the future residential water use shown in column S. All the communities in Method 1 have existing residential gpcd at or below 80, so their existing gpcd is carried forward.

6. Column T, the future non-residential portion of projected demand, is calculated by adding two factors to existing non-residential water use:

(a) Additional non-residential ADD due to population change

Projected population change between present and future is multiplied by the existing "non-residential gpcd" which results in the new non-residential ADD for the additional population. (In cases where population is projected to decline, this non-residential water use also will decline.)

(b) Allowance for new non-residential uses independent of population change

Communities often experience changes in commercial or industrial sectors which is not directly linked to population change. In order to plan for changes in non-residential water use not tied to population change, and in lieu of specific economic projections for each community, a growth factor based on past economic trends is included.

The average non-residential water use was estimated over the past 10 year period. The volume change between the first three years of the period and the last three years was used to estimate the change expected to occur in succeeding decades, unless the community could provide specific information. Where non-residential water use has shown a decline between the two periods, the non-residential water use is held constant.

7. In calculating Column U, unaccounted-for water, the methodology assumes that if existing UAW is 10 percent or lower, the existing percentage will continue in the future. If the UAW is greater than 10%, it is assumed that there will be a reduction in UAW during the planning period to reach 10%.

8. Column V, the forcasted ADD, was calculated by adding columns S, T, and U.

Water Needs Forecast - Method #2

Method #1 could be applied in those communities where it was possible to obtain disaggregated data on residential, non-residential, and UAW in order to project those components. Due to a low percentage of metering and/or inaccurate metering, a number of communities do not have adequate data to permit a disaggregated water use forecast.

The method assumes that the gpcd of any additional population will have a gpcd of no more than 70, and makes no allowance for unaccounted-for water. Therefore, towns which have a high residential gpcd (greater than 80) and/or a high unaccounted-for water component (greater than 15%) are subject to Method 2.

The main assumptions of Method #2 and the calculations used to arrive at the demand projections are detailed below.

1. Columns A through G are calculated as in Method #1.

2. Columns H through N are shown where possible, or otherwise shown as unknowns. Until these communities are either more fully metered or are able to reliably distinguish their UAW, a disaggregated methodology cannot be used.

3. Columns P through S show the projected service population .

4. Column T shows the increase in the residential service population between base service population and the projected service population, and is derived by subtracting S from E.

5. Column U shows the additional increase in residential demand based solely on population change, and is derived by multiplying I by T. If column I is greater than 70, the future residential gpcd is kept at 70.

7. One part of Column U, the increase in the non-residential portion of projected demand, is calculated as shown in Step 6(a) of Method #1. For the portion of growth in non-residential sectors independent of population change, a method similar to step 6(b) was used with a slight variation. As in Method 1, the average non-residential water use was estimated for the first and last three years of the previous decade. The volume change in non-residential water use for this time period was then determined. However, for Method #2 communities, the growth rate was slowed to reflect the inadequacy of the information and the assumption that additional water is available in the water supply system.

8. The future ADD, column X, was calculated by adding the base ADD, column W, to the increase in residential demand, column U, and column V, the increase in non-residential demand.

Subject: Generic Water Supply Needs Forecast Explanation
Method 1:

Column A – Population based on 2000 census
Column B – Population served in 2000, in percentage
Column C – 2000 Out of town population (assumed 3 months)
Column D – 2000 Seasonal population (adjusted for 12 months)
Column E – 2000 base service population (= Column A times Column B + Column D)
Column F – Averaged Daily Demand between 1998 and 2000, MGD
Column G – Averaged overall gallons per capita per day between 1998 and 2000 (= Column F/Column E)
Column H – Averaged residential water consumption between 1998 and 2000, in percentage
Column I – Averaged residential water consumption, gallons per capita per day (= Column J/ Column F)
Column J – Averaged residential averaged daily demand between 1998 and 2000, MGD
Column K – Non-residential water consumption between 1998 and 2000, in percentage (= total pumpage – residential consumption – unaccounted-for water)
Column L – Non-residential water consumption between 1998 and 2000 from annual reports, MGD (= total pumpage – residential consumption – unaccounted-for-water)
Column M – Unaccounted-for water, in percentage
Column N – Unaccounted-for water in averaged daily demand, in MGD
Column O – 2005 population projection based on (SREPDD or MISER) plus seasonal population adjustment in Column D.
Column P - Percent population served (same as Column B)
Column Q – Population served in future year
Column R – Future year residential water demand forecast, in MGD
Column S – Future year non-residential ADD, in MGD due to population growth
Column T – Future year non-residential ADD, in MGD due to commercial/industrial growth
Column U – Future year non-residential ADD, in MGD partly due to constant growth
Column V – Future year total non-residential ADD, in MGD
Column W – Future year unaccounted-for water forecast, in MGD
Column X – Future year total Water Demand Forecast (Column R + Column V + Column W)

Method 2:

Column A – Population based on 2000 census
Column B – Population served in 2000, in percentage
Column C – 2000 Out of town population (assumed 3 months)
Column D – 2000 Seasonal population (adjusted for 12 months)
Column E – 2000 base service population (= Column A times Column B + Column D)
Column F – Averaged Daily Demand between 1998 and 2000, MGD

Column G – Averaged overall gallons per capita per day between 1998 and 2000 (= Column F/Column E)

Column H – Averaged residential water consumption between 1998 and 2000, in percentage

Column I – Averaged residential water consumption, gallons per capita per day (= Column J/ Column F)

Column J – Averaged residential averaged daily demand between 1998 and 2000, MGD

Column K – Non-residential water consumption between 1998 and 2000, in percentage (= total pumpage – residential consumption – unaccounted-for water)

Column L – Non-residential water consumption between 1998 and 2000 from annual reports, MGD (= total pumpage – residential consumption – unaccounted-for-water)

Column M – Unaccounted-for water, in percentage

Column N – Unaccounted-for water in averaged daily demand, in MGD

Column O – 2005 population projection based on (SREPDD or MISER) plus seasonal population adjustment in Column D.

Column P - Percent population served (same as Column B)

Column Q – Population served in future year

Column R – Population change between 2000 and future year

Column S – Future year residential water consumption rate, actual or 70 gpcd

Column T – Future year increase in residential ADD, in MGD

Column U – Future year non-residential ADD, in MGD

Column V – Average water use between 1998 and 2000, in MGD

Column W – Future year total Water Demand Forecast (Column T + Column U + Column V)

APPENDIX B

DEP Annual Report Summary

Appendix B - 1998 to 2002 Annual Statistical Report Data

Town- Attleboro

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	1,668,511,000	4,571,263	0.56	930,268,900	2,548,682	0.30	1,368,358	0.14	238,791,488	654,223
2001	2,020,990,000	5,536,959	0.52	1,054,623,152	2,889,378	0.28	1,561,784	0.20	396,315,619	1,085,796
2000	1,844,320,000	5,052,932	0.54	999,661,608	2,738,799	0.31	1,585,325	0.14	266,014,774	728,808
1999	2,049,990,000	5,616,411	0.54	1,100,000,000	3,013,699	0.29	1,605,452	0.18	364,000,000	997,260
1998	1,886,670,000	5,168,959	0.57	1,069,869,367	2,931,149	0.30	1,568,228	0.13	244,397,553	669,582
Avg. 02-98	**1,894,096,200**	**5,189,305**	**0.55**	**1,030,884,605**	**2,824,341**	**0.30**	**1,537,829**	**0.16**	**301,903,887**	**827,134**

Town- Dighton

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	149,662,000	410,033	0.55	81,646,000	223,688	0.25	104,060	0.20	30,034,000	82,285
2001	161,965,000	443,740	0.64	103,300,000	283,014	0.26	114,408	0.10	16,906,000	46,318
2000	189,093,558	518,065	0.69	129,824,228	355,683	0.26	133,238	0.06	10,637,490	29,144
1999	177,610,404	486,604	0.71	126,781,426	347,346	0.23	111,000	0.06	10,313,800	28,257
1998	171,428,674	469,668	0.65	110,610,702	303,043	0.25	115,812	0.11	18,546,470	50,812
Avg. 02-98	**169,951,927**	**465,622**	**0.65**	**110,432,471**	**302,555**	**0.25**	**115,704**	**0.11**	**17,287,552**	**47,363**

Town- Fall River

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	4,729,367,000	12,957,170	0.57	2,707,090,000	7,416,685	0.28	3,596,909	0.15	709,405,050	1,943,575
2001	4,430,490,000	12,138,329	0.47	2,082,340,000	5,705,041	0.39	4,733,918	0.14	620,270,000	1,699,370
2000	5,138,320,000	14,077,589	0.36	1,849,800,000	5,067,945	0.53	7,461,123	0.11	565,210,000	1,548,521
1999	5,647,610,000	15,472,904	0.36	2,033,130,000	5,570,219	0.53	8,200,658	0.11	621,240,000	1,702,027
1998	4,996,150,000	13,688,082	0.36	1,798,560,000	4,927,562	0.53	7,254,877	0.11	549,560,000	1,505,644
Avg. 02-98	**4,988,387,400**	**13,666,815**	**0.42**	**2,094,184,000**	**5,737,490**	**0.45**	**6,249,497**	**0.12**	**613,137,010**	**1,679,827**

Town- Foxboro

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	676,964,930	1,854,698	0.71	483,917,393	1,325,801	0.23	419,261	0.06	40,017,136	109,636
2001	755,620,792	2,070,194	0.66	496,060,343	1,359,069	0.26	532,893	0.09	65,054,621	178,232
2000	671,951,360	1,840,963	0.70	470,082,661	1,287,898	0.23	422,828	0.07	47,536,369	130,237
1999	698,794,890	1,914,507	0.71	495,905,626	1,358,646	0.24	461,610	0.05	34,401,550	94,251
1998	878,247,005	2,406,156	0.51	446,054,266	1,222,066	0.45	1,093,679	0.04	33,000,000	90,411
Avg. 02-98	**736,315,795**	**2,017,304**	**0.66**	**478,404,058**	**1,310,696**	**0.28**	**586,054**	**0.06**	**44,001,935**	**120,553**

Town- Mansfield

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002										
2001										
2000	751,070,623	2,057,728	0.71	529,626,206	1,451,031	0.20	406,958	0.10	72,904,832	199,739
1999	734,434,787	2,012,150	0.79	581,692,485	1,593,678	0.13	257,993	0.08	58,574,798	160,479
1998	702,754,367	1,925,354	0.79	551,947,704	1,512,185	0.16	307,170	0.06	38,689,523	105,999
Avg. 02-98	**729,419,926**	**1,998,411**	**0.76**	**554,422,132**	**1,518,965**	**0.16**	**324,040**	**0.08**	**56,723,051**	**155,406**

Town- North Attleborough

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	1,086,224,756	2,975,958	0.69	747,680,406	2,048,439	0.18	525,792	0.13	146,630,413	401,727
2001	1,071,076,816	2,934,457	0.76	818,835,940	2,243,386	0.08	224,186	0.16	170,413,071	466,885
2000	1,002,765,021	2,747,301	0.65	647,499,281	1,773,971	0.21	564,406	0.15	149,257,513	408,925
1999	1,160,036,470	3,178,182	0.68	790,081,883	2,164,608	0.18	572,215	0.14	161,096,289	441,360
1998	992,202,954	2,718,364	0.69	681,903,954	1,868,230	0.22	595,288	0.09	93,019,000	254,847
Avg. 02-98	**1,062,461,203**	**2,910,853**	**0.69**	**737,200,293**	**2,019,727**	**0.17**	**496,377**	**0.14**	**144,083,257**	**394,749**

Town- Plainville

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	235,785,000	645,986	0.74	174,000,000	476,712	0.19	122,992	0.07	16,893,000	46,282
2001	243,422,510	666,911	0.70	170,410,000	466,877	0.16	104,985	0.14	34,692,910	95,049
2000	238,038,800	652,161	0.52	123,000,000	336,986	0.34	218,597	0.15	35,250,800	96,578
1999	225,187,700	616,953	0.51	115,858,700	317,421	0.34	208,838	0.15	33,103,000	90,693
1998	248,872,400	681,842	0.69	172,540,000	472,712	0.14	93,941	0.17	42,044,000	115,189
Avg. 02-98	**238,261,282**	**652,771**	**0.63**	**151,161,740**	**414,142**	**0.23**	**149,871**	**0.14**	**32,396,742**	**88,758**

Town- Raynham

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002										
2001										
2000	402,240,000	1,102,027	0.54	218,806,000	599,468	0.37	411,479	0.08	33,244,000	91,079
1999	441,048,000	1,208,351	0.55	243,591,000	667,373	0.34	415,778	0.10	45,698,000	125,200
1998	383,106,000	1,049,605	0.58	223,580,000	612,548	0.26	277,822	0.15	58,121,000	159,236
Avg. 02-98	**408,798,000**	**1,119,995**	**0.56**	**228,659,000**	**626,463**	**0.33**	**368,360**	**0.11**	**45,687,667**	**125,172**

Town- Seekonk

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	471,800,000	1,292,603	0.72	340,290,000	932,301	0.21	271,452	0.07	32,430,000	88,849
2001	455,910,000	1,249,068	0.77	351,930,000	964,192	0.16	196,932	0.07	32,100,000	87,945
2000	508,230,000	1,392,411	0.68	347,710,000	952,630	0.20	282,247	0.11	57,500,000	157,534
1999	612,285,550	1,677,495	0.69	425,000,000	1,164,384	0.20	328,587	0.11	67,351,411	184,524
1998	618,733,350	1,695,160	0.70	430,907,004	1,180,567	0.18	312,743	0.12	73,675,326	201,850
Avg. 02-98	**533,391,780**	**1,461,347**	**0.71**	**379,167,401**	**1,038,815**	**0.19**	**278,392**	**0.10**	**52,611,347**	**144,141**

Town- Somerset

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	1,156,404,000	3,168,230	0.45	520,311,000	1,425,510	0.50	1,585,537	0.05	57,372,000	157,184
2001	1,209,887,000	3,314,759	0.37	453,298,000	1,241,912	0.51	1,692,490	0.11	138,830,000	380,356
2000	1,159,402,000	3,176,444	0.44	512,397,000	1,403,827	0.48	1,521,052	0.08	91,821,000	251,564
1999	1,097,658,000	3,007,282	0.49	537,061,500	1,471,401	0.39	1,174,922	0.12	131,750,000	360,959
1998	1,060,263,000	2,904,830	0.49	514,273,000	1,408,967	0.41	1,177,229	0.11	116,301,550	318,634
Avg. 02-98	**1,136,722,800**	**3,114,309**	**0.45**	**507,468,100**	**1,390,324**	**0.46**	**1,430,246**	**0.09**	**107,214,910**	**293,739**

Town- Swansea

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002	443,863,710	1,216,065	0.67	297,832,530	815,980	0.26	314,961	0.07	31,070,460	85,125
2001	417,850,510	1,144,796	0.66	275,469,640	754,711	0.26	297,595	0.08	33,758,710	92,490
2000	471,989,110	1,293,121	0.66	311,601,840	853,704	0.25	323,280	0.09	42,390,000	116,137
1999	507,488,710	1,390,380	0.70	355,242,097	973,266	0.21	294,761	0.09	44,659,006	122,353
1998	478,219,638	1,310,191	0.71	339,535,943	930,235	0.23	301,344	0.06	28,693,178	78,611
Avg. 02-98	**463,882,336**	**1,270,911**	**0.68**	**315,936,410**	**865,579**	**0.24**	**306,388**	**0.08**	**36,114,271**	**98,943**

Town- Wrentham

Year	Water Use (gal.)	ADD	% Res.	Res. Water Use (gal)	Res. ADD	% Non-Res.	Non-Res ADD	% UAW	Unaccounted Water Use	UAW ADD
2002							0			
2001	384,571,968	1,053,622	0.62	237,727,469	651,308	0.17	176,431	0.21	82,447,103	225,882
2000	338,905,640	928,509	0.65	219,039,336	600,108	0.19	173,070	0.17	56,695,650	155,331
1999	370,310,700	1,014,550	0.67	247,003,280	676,721	0.17	173,540	0.16	59,965,310	164,289
1998	348,129,700	953,780	0.63	220,657,907	604,542	0.14	137,462	0.22	77,298,293	211,776
Avg. 02-98	**360,479,502**	**987,615**	**0.64**	**231,106,998**	**633,170**	**0.17**	**132,101**	**0.19**	**69,101,589**	**189,319**

File name: x:1214\Water Projection\Method 1&2 SRPEDD-projected water Final.xls

APPENDIX C

Growth Rate Based on Town’s Information and Past Pumpages

APPENDIX C - Growth Rate Based on Town's Information and Past Pumpages

COMMUNITY	1990 NET Pumpahe 1990 RES 1990 UAW 1990 COMMND	1991 NET Pumpage 1991 RES 1991 UAW 1991 COM/IND	1992 NET Pumpage 1992 RES 1992 UAW 1992 COM/IND	1993 NET Pumpage 1993 RES 1993 UAW 1993 COM/IND	1998 NET Pumpage 1998 RES 1998 UAW 1998 COM/IND	1999 NET Pumpage 1999 RES 1999 UAW 1999 COM/IND	2000 NET Pumpage 2000 RES 2000 UAW 2000 COM/IND	Ind/Com Growth Rate Calculated	Ind/Com Growth Rate Given by Town Employees
ATTLEBORO		?	?	?	1,886,670,000	2,049,990,000	1,844,320,000	14%	--
		?	?	?	1,069,869,367	1,100,000,000	999,661,608	Could Not Find Data	
		?	?	?	244,397,553	364,000,000	266,014,774		
	509,908,608	?	?	?	572,403,080	585,990,000	578,643,618	6,910,362	
	1,397,010				1,568,228	1,605,452	1,585,325	18,932	
DIGHTON		--	--	--	171,428,674	177,610,404	186,767,160	0%	0.00%
		--	--	--	110,610,702	126,931,426	129,824,228		
		--	--	--	18,546,470	10,463,800	10,637,490		
	140,514,790	--	--	--	42,271,502	40,215,178	46,305,442	-9,758,408	
FALL RIVER		5,079,293,000	5,217,864,000	5,291,377,500	4,891,850,000	5,544,380,000	5,018,750,000	4.83%	--
		1,777,752,550	1,826,252,400	1,851,982,125	1,798,560,000	2,033,130,000	1,849,800,000		
		888,876,275	782,679,600	793,706,625	549,560,000	621,240,000	565,210,000		
	2,340,580,005	2,412,664,175	2,608,932,000	2,645,688,750	2,543,730,000	2,890,010,000	2,603,740,000	4.83%	
FOXBORO		814,420,000	790,128,797	865,573,000	878,122,505	698,794,890	671,951,360	0.00%	--
		367,949,000	345,482,490	388,315,028	446,054,266	495,905,626	470,082,661	Negative Growth	
		203,605,000	213,334,775	233,704,710	162,563,807	59,758,135	47,536,369		
		242,866,000	231,311,532	243,553,262	269,504,432	143,131,129	154,332,330	-21.01%	
MANSFIELD		?	?	?	702,754,367	734,434,787	751,070,623	0.00%	--
		?	?	?	551,947,704	581,692,485	529,626,206	Could Not Find Data	
		?	?	?	38,189,523	58,574,798	72,904,832		
	257,853,630	?	?	?	112,617,140	94,167,504	148,539,585	-13,941,222	
NORTH ATTLEBOROUGH		963,631,500	1,006,405,303	1,107,820,052	992,202,954	1,160,036,470	1,002,765,021	0.00%	--
		356,764,972	488,986,529	677,391,418	681,903,954	790,081,883	647,499,281	Negative Growth	
		435,096,111	351,207,000	258,122,072	93,019,000	161,096,289	149,257,513		
		171,770,417	166,211,774	172,306,562	217,280,000	208,858,298	206,008,227	23.88%	
PLAINVILLE	197,979,868	218,119,790	204,269,000	194,317,000	248,872,400	225,187,700	238,038,800	0.00%	--
	97,010,135	106,878,697	90,400,000	130,344,500	172,540,000	115,858,700	123,000,000	Negative Growth	
	29,696,980	32,717,969	37,000,000	25,574,910	42,044,000	33,103,000	35,250,800		
	7,127,275,248	78,523,124	76,869,000	38,397,590	34,288,400	76,226,000	79,788,000	-116,244	
REHOBOTH		0	0	0	0	0	0	0.00%	--
		0	0	0	0	0	0		
		0	0	0	0	0	0		
		0	0	0	0	0	0		
SEEKONK	374,069,380	?	?	?	590,681,350	612,285,550	508,230,000	0.00%	--
	287,217,940	?	?	?	430,907,004		347,710,000	Could Not Find Data	
		?	?	?	73,675,326	67,351,411	57,500,000		
	459,851,440	?	?	?	86,099,020		103,020,000	-36,529,193	
SOMERSET	1,165,499,000	--	--	--	1,060,263,000	1,097,658,000	1,159,402,000	--	2.00%
		--	--	--	514,273,000	537,061,500	512,397,000		
		--	--	--	20,144,050	131,750,000	91,821,000		
	979,477,000	--	--	--	525,845,950	428,846,500	555,184,000	-47,618,485	
SWANSEA		455,236,190	448,406,190	519,932,140	478,219,638	507,488,710	471,989,110	1.59%	--
		209,317,795	312,975,032	370,932,140	339,535,943	355,242,097	311,601,840		
		68,285,429	57,187,400	51,000,000	4,782,196	44,659,006	42,390,000		
	93,436,624	177,632,966	78,243,758	98,000,000	133,901,499	107,587,607	117,997,270	186,988	
WRENTHAM		409,906,500	389,620,100	453,599,400	341,200,700	369,154,000	360,554,300	0.00%	--
		180,979,845	183,364,208	204,210,190	220,657,907	247,003,380	219,039,336	Negative Growth	
		168,828,685	136,184,500	183,347,311	77,298,293	59,968,310	56,695,650		
		60,097,970	70,071,392	66,041,899	43,244,500	62,182,310	84,819,314	-198,838	

APPENDIX D

Water Needs Forecast
2005 to 2020
Using SRPEDD/MAPC Data

APPENDIX D-1: 2005 TO 2020 WATER SUPPLY NEEDS FORECAST USING SRPEDD/MAPC DATA - METHOD 1

2005 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG, GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2005 POP PROJECT	P 2005 % SERV POP	Q 2005 SERV POP	R 2005 RES ADD MGD	S 2005 NON RES ADD, MGD (pop growth)	T 2005 NON RES ADD, MGD (non res growth)	U 2005 NON RES ADD, MGD (constant)	V 2005 TOTAL NON RES ADD, MGD	W 2005 UAW ADD, MGD	X 2005 TOTAL ADD, MGD
DIGHTON	6,175	62.9%	0	16	3,902	0.47	119.3	64.6%	77.5	0.30	24.9%	0.12	10.6%	0.05	6,605	62.9%	4,173	0.32	0.12	0.00	0.00	0.12	0.05	0.50
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	92,077	102.2%	94,142	5.75	6.26	0.15	0.00	6.41	1.35	13.51
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	16,098	102.5%	16,508	1.30	0.58	0.00	0.00	0.58	0.12	2.00
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	24,739	98.1%	24,280	1.68	0.36	0.00	0.00	0.36	0.17	2.20
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	28,118	95.8%	26,934	2.09	0.51	0.06	0.00	0.57	0.30	2.96
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	8,115	110.6%	8,978	0.44	0.16	0.00	0.00	0.16	0.07	0.66
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	13,665	98.3%	13,436	1.06	0.28	0.00	0.00	0.28	0.14	1.48
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	17,648	99.9%	17,638	0.88	0.31	0.00	0.00	0.31	0.10	1.29

2010 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B Percent 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG, GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2010 POP PROJECT	P 2010 % SERV POP	Q 2010 SERV POP	R 2010 RES ADD MGD	S 2010 NON RES ADD, MGD (pop growth)	T 2010 NON RES ADD, MGD (non res growth)	U 2010 NON RES ADD, MGD (constant)	V 2010 TOTAL NON RES ADD, MGD	W 2010 UAW ADD, MGD	X 2010 TOTAL ADD, MGD
DIGHTON	6,175	62.9%	0	16	3,902	0.47	119.3	64.6%	77.5	0.30	24.9%	0.12	10.6%	0.05	7,065	62.9%	4,462	0.35	0.13	0.00	0.00	0.13	0.05	0.53
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	91,938	102.2%	94,000	5.74	6.25	0.15	0.00	6.40	1.35	13.49
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	16,940	102.5%	17,372	1.37	0.61	0.00	0.00	0.61	0.13	2.11
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	27,305	98.1%	26,798	1.85	0.39	0.00	0.00	0.39	0.19	2.43
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	29,127	95.8%	27,900	2.17	0.53	0.06	0.00	0.59	0.31	3.07
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	8,572	110.6%	9,484	0.46	0.17	0.00	0.00	0.17	0.07	0.70
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	13,910	98.3%	13,677	1.08	0.29	0.00	0.00	0.29	0.15	1.51
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	17,942	99.9%	17,932	0.89	0.32	0.00	0.00	0.32	0.10	1.32

2015 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG, GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2015 POP PROJECT	P 2015 % SERV POP	Q 2015 SERV POP	R 2015 RES ADD MGD	S 2015 NON RES ADD, MGD (pop growth)	T 2015 NON RES ADD, MGD (non res growth)	U 2015 NON RES ADD, MGD (constant)	V 2015 TOTAL NON RES ADD, MGD	W 2015 UAW ADD, MGD	X 2015 TOTAL ADD, MGD
DIGHTON	6,175	62.9%	0	16	3,902	0.47	119.3	64.6%	77.5	0.30	24.9%	0.12	10.6%	0.05	7,496	62.9%	4,733	0.37	0.14	0.00	0.00	0.14	0.06	0.56
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	92,355	102.2%	94,426	5.76	6.28	0.15	0.00	6.43	1.35	13.55
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	17,290	102.5%	17,731	1.39	0.62	0.00	0.00	0.62	0.13	2.15
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	29,649	98.1%	29,099	2.01	0.43	0.00	0.00	0.43	0.20	2.64
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	30,103	95.8%	28,835	2.24	0.55	0.06	0.00	0.61	0.32	3.17
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	9,006	110.6%	9,964	0.49	0.18	0.00	0.00	0.18	0.07	0.73
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	14,150	98.3%	13,913	1.09	0.29	0.00	0.00	0.29	0.15	1.54
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	18,231	99.9%	18,220	0.91	0.32	0.00	0.00	0.32	0.10	1.34

2020 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG, GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2020 POP PROJECT	P 2020 % SERV POP	Q 2020 SERV POP	R 2020 RES ADD MGD	S 2020 NON RES ADD, MGD (pop growth)	T 2020 NON RES ADD, MGD (non res growth)	U 2020 NON RES ADD, MGD (constant)	V 2020 TOTAL NON RES ADD, MGD	W 2020 UAW ADD, MGD	X 2020 TOTAL ADD, MGD
DIGHTON	6,175	62.9%	0	16	3,902	0.47	119.3	64.6%	77.5	0.30	24.9%	0.12	10.6%	0.05	7,954	62.9%	5,022	0.39	0.15	0.00	0.00	0.15	0.06	0.60
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	92,495	102.2%	94,569	5.77	6.29	0.15	0.00	6.44	1.36	13.57
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	17,148	102.5%	17,585	1.38	0.62	0.00	0.00	0.62	0.13	2.13
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	32,195	98.1%	31,597	2.18	0.47	0.00	0.00	0.47	0.22	2.87
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	31,111	95.8%	29,801	2.31	0.57	0.06	0.00	0.63	0.33	3.27
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	9,462	110.6%	10,468	0.51	0.18	0.00	0.00	0.18	0.08	0.77
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	14,395	98.3%	14,154	1.11	0.30	0.00	0.00	0.30	0.15	1.56
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	18,525	99.9%	18,514	0.92	0.33	0.00	0.00	0.33	0.11	1.36

APPENDIX D-2: 2005 TO 2020 WATER SUPPLY NEEDS FORECAST USING SRPEDD/MAPC DATA - METHOD 2

2005 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD MGD	O 2005 POP PROJECT	P 2005 % SERV POP	Q 2005 SERV POP	R POP CHANG 1998-2005	S 2005 RES. GPCD FACTOR	T 2005 INC. IN RES ADD, MGD	U 2005 INC. IN NON RES ADD, MGD	V 1998-2002 ADD MGD	W 2005 TOTAL ADD MGD
ATTLEBORO	42068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	43721	94.1%	41,163	1,556	70.0	0.11	0.06	5.19	5.36
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	18,536	94.78%	17,569	286	70.0	0.02	0.17	3.11	3.30
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	10,678	82.58%	8,829	71	70.0	0.00	0.00	0.99	0.99

2010 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD MGD	O 2010 POP PROJECT	P 2010 % SERV POP	Q 2010 SERV POP	R POP CHANG 1998-2010	S 2010 RES. GPCD FACTOR	T 2010 INC. IN RES ADD, MGD	U 2010 INC. IN NON RES ADD, MGD	V 1998-2002 ADD MGD	W 2010 TOTAL ADD MGD
ATTLEBORO	42068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	45,440	94.1%	42,782	3,175	70.0	0.22	0.12	5.19	5.53
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	18,842	94.8%	17,859	576	70.0	0.04	0.33	3.11	3.49
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,392	82.6%	9,419	661	70.0	0.05	0.01	0.99	1.04

2015 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD MGD	O 2015 POP PROJECT	P 2015 % SERV POP	Q 2015 SERV POP	R POP CHANG 1998-2015	S 2015 RES. GPCD FACTOR	T 2015 INC. IN RES ADD, MGD	U 2015 INC. IN NON RES ADD, MGD	V 1998-2002 ADD MGD	W 2015 TOTAL ADD MGD
ATTLEBORO	42068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	47,096	94.1%	44,341	4,734	70.0	0.33	0.18	5.19	5.70
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	19,144	94.8%	18,146	863	70.0	0.06	0.50	3.11	3.68
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,686	82.6%	9,661	903	70.0	0.06	0.01	0.99	1.07

2020 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD MGD	O 2020 POP PROJECT	P 202000.0% % SERV POP	Q 2020 SERV POP	R POP CHANG 1998-2020	S 2020 RES. GPCD FACTOR	T 2020 INC. IN RES ADD, MGD	U 2020 INC. IN NON RES ADD, MGD	V 1998-2002 ADD MGD	W 2020 TOTAL ADD MGD
ATTLEBORO	42068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	48,812	94.1%	45,956	6,349	70.0	0.44	0.25	5.19	5.88
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	19,450	94.8%	18,436	1,153	70.0	0.08	0.67	3.11	3.86
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,703	82.6%	9,675	917	70.0	0.06	0.01	0.99	1.07

APPENDIX D-3: 2005 TO 2020 WATER SUPPLY NEEDS FORECAST USING SRPEDD DATA

2005 WATER NEEDS FORECAST

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
COMMUNITY	2000 CENSUS POP	2000 SERVICE POP	2000 OUT OF TOWN POP	2000 SESFACT POP	2000 BASE SERVICE POP	1998-2000 ADD, MGD	1998-2000 AVG, GPCD	1998-2000 RES. %	1998-2000 RES. GPCD	1998-2000 RES. ADD, MGD	1998-2000 NON RES. %	1998-2000 NON RES. ADD, MGD	1998-2000 UAW %	1998-2000 UAW ADD, MGD	2005 POP PROJECT	2005 % SERV POP	2005 SERV POP	2005 RES ADD, MGD	2005 NON RES ADD, MGD (pop growth)	2005 NON RES ADD, MGD (non res growth)	2005 NON RES ADD, MGD (constant)	2005 TOTAL NON RES ADD, MGD	2005 UAW ADD, MGD	2005 TOTAL ADD, MGD	LESS THAN 10 %	GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	43,721	94.1%	41,163	2.94	1.60	0.00	0.00	1.60	0.50	5.04	0.85	0.50
SOMERSET	18,234	94.8%	0	0	17,282	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	18,556	94.8%	17,587	1.41	1.46	0.14	0.00	1.60	0.32	3.33	0.32	0.33
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.19	10,678	82.6%	8,829	0.64	0.13	0.00	0.00	0.13	0.09	0.86	0.18	0.09

2010 WATER NEEDS FORECAST

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
COMMUNITY	2000 CENSUS POP	2000 SERVICE POP	2000 OUT OF TOWN POP	2000 SESFACT POP	2000 BASE SERVICE POP	1998-2000 ADD, MGD	1998-2000 AVG, GPCD	1998-2000 RES. %	1998-2000 RES. GPCD	1998-2000 RES. ADD, MGD	1998-2000 NON RES. %	1998-2000 NON RES. ADD, MGD	1998-2000 UAW %	1998-2000 UAW ADD, MGD	2010 POP PROJECT	2010 % SERV POP	2010 SERV POP	2010 RES ADD, MGD	2010 NON RES ADD, MGD (pop growth)	2010 NON RES ADD, MGD (non res growth)	2010 NON RES ADD, MGD (constant)	2010 TOTAL NON RES ADD, MGD	2010 UAW ADD, MGD	2010 TOTAL ADD, MGD	LESS THAN 10 %	GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	45,440	94.1%	42,782	3.05	1.66	0.00	0.00	1.66	0.52	5.24	0.88	0.52
SOMERSET	18,234	94.8%	0	0	17,282	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	18,842	94.8%	17,858	1.44	1.48	0.29	0.00	1.76	0.33	3.54	0.33	0.36
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,392	82.6%	9,419	0.68	0.14	0.00	0.00	0.14	0.09	0.92	0.19	0.09

2015 WATER NEEDS FORECAST

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
COMMUNITY	2000 CENSUS POP	2000 SERVICE POP	2000 OUT OF TOWN POP	2000 SESFACT POP	2000 BASE SERVICE POP	1998-2000 ADD, MGD	1998-2000 AVG, GPCD	1998-2000 RES. %	1998-2000 RES. GPCD	1998-2000 RES. ADD, MGD	1998-2000 NON RES. %	1998-2000 NON RES. ADD, MGD	1998-2000 UAW %	1998-2000 UAW ADD, MGD	2015 POP PROJECT	2015 % SERV POP	2015 SERV POP	2015 RES ADD, MGD	2015 NON RES ADD, MGD (pop growth)	2015 NON RES ADD, MGD (non res growth)	2015 NON RES ADD, MGD (constant)	2015 TOTAL NON RES ADD, MGD	2015 UAW ADD, MGD	2015 TOTAL ADD, MGD	LESS THAN 10 %	GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	47,096	94.1%	44,341	3.16	1.72	0.00	0.00	1.72	0.54	5.43	0.92	0.54
SOMERSET	18,234	94.8%	0	0	17,282	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	19,144	94.8%	18,145	1.46	1.50	0.43	0.00	1.93	0.35	3.74	0.35	0.38
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,686	82.6%	9,661	0.70	0.15	0.00	0.00	0.15	0.09	0.94	0.20	0.09

2020 WATER NEEDS FORECAST

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
COMMUNITY	2000 CENSUS POP	2000 SERVICE POP	2000 OUT OF TOWN POP	2000 SESFACT POP	2000 BASE SERVICE POP	1998-2000 ADD, MGD	1998-2000 AVG, GPCD	1998-2000 RES. %	1998-2000 RES. GPCD	1998-2000 RES. ADD, MGD	1998-2000 NON RES. %	1998-2000 NON RES. ADD, MGD	1998-2000 UAW %	1998-2000 UAW ADD, MGD	2020 POP PROJECT	2020 % SERV POP	2020 SERV POP	2020 RES ADD, MGD	2020 NON RES ADD, MGD (pop growth)	2020 NON RES ADD, MGD (non res growth)	2020 NON RES ADD, MGD (constant)	2020 TOTAL NON RES ADD, MGD	2020 UAW ADD, MGD	2020 TOTAL ADD, MGD	LESS THAN 10 %	GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	48,812	94.1%	45,956	3.28	1.78	0.00	0.00	1.78	0.56	5.62	0.95	0.56
SOMERSET	18,234	94.8%	0	0	17,282	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	19,450	94.8%	18,435	1.48	1.53	0.57	0.00	2.10	0.37	3.96	0.37	0.40
WRENTHAM	10,554	82.6%	42	11	8,758	0.99	112.8	64.1%	72.3	0.63	16.7%	0.13	19.1%	0.22	11,703	82.6%	9,664	0.70	0.15	0.00	0.00	0.15	0.09	0.94	0.20	0.09

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APPENDIX E

Water Needs Forecast
2005 to 2020
Using MISER Data

APPENDIX E-1: 2005 to 2020 WATER SUPPLY NEEDS FORECAST USING MISER DATA - METHOD 1

2005 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2005 POP PROJECT	P 2005 % SERV POP	Q 2005 SERV POP	R 2005 RES ADD,MGD	S 2005 NON RES ADD, MGD (pop growth)	T 2005 NON RES ADD, MGD (non res growth)	U 2005 NON RES ADD, MGD (constant)	V 2005 TOTAL NON RES ADD, MGD	W 2005 UAW ADD, MGD	X 2005 TOTAL ADD, MGD
DIGHTON	6,175	63.0%	0	16	3,893	0.47	119.6	64.6%	77.7	0.30	24.9%	0.12	10.6%	0.05	6,763	63.0%	4,279	0.33	0.13	0.00	0.00	0.13	0.05	0.51
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	93,285	102.2%	95,377	5.82	6.34	0.15	0.00	6.49	1.37	13.68
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	16,645	102.5%	17,069	1.34	0.60	0.00	0.00	0.60	0.13	2.07
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69	1.52	16.2%	0.32	7.7%	0.16	24,454	98.1%	24,000	1.66	0.35	0.00	0.00	0.35	0.17	2.18
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	28,346	95.8%	27,152	2.11	0.52	0.06	0.00	0.58	0.30	2.99
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	8,253	110.6%	9,131	0.44	0.16	0.00	0.00	0.16	0.07	0.67
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	13,959	98.3%	13,725	1.08	0.29	0.00	0.00	0.29	0.15	1.52
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	17,781	99.9%	17,771	0.89	0.31	0.00	0.00	0.32	0.10	1.30

2010 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD,MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2010 POP PROJECT	P 2010 % SERV POP	Q 2010 SERV POP	R 2010 RES ADD, MGD	S 2010 NON RES ADD, MGD (pop growth)	T 2010 NON RES ADD, MGD (non res growth)	U 2010 NON RES ADD, MGD (constant)	V 2010 TOTAL NON RES ADD, MGD	W 2010 UAW ADD, MGD	X 2010 TOTAL ADD, MGD
DIGHTON	6,175	63.0%	0	16	3,893	0.47	119.6	64.6%	77.7	0.30	24.9%	0.12	10.6%	0.05	6,960	63.04%	4,404	0.34	0.13	0.00	0.00	0.13	0.05	0.53
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	94,226	102.24%	96,339	5.88	6.41	0.15	0.00	6.56	1.38	13.82
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	16,901	102.55%	17,332	1.36	0.61	0.00	0.00	0.61	0.13	2.10
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	26,116	98.14%	25,631	1.77	0.38	0.00	0.00	0.38	0.18	2.33
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	29,174	95.79%	27,945	2.17	0.53	0.06	0.00	0.59	0.31	3.07
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	8,423	110.63%	9,319	0.45	0.16	0.00	0.00	0.16	0.07	0.69
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	14,128	98.32%	13,891	1.09	0.29	0.00	0.00	0.29	0.15	1.53
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	18,052	99.94%	18,042	0.90	0.32	0.00	0.00	0.32	0.10	1.32

2015 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2015 POP PROJECT	P 2015 % SERV POP	Q 2015 SERV POP	R 2015 RES ADD, MGD	S 2015 NON RES ADD, MGD (pop growth)	T 2015 NON RES ADD, MGD (non res growth)	U 2015 NON RES ADD, MGD (constant)	V 2015 TOTAL NON RES ADD, MGD	W 2015 UAW ADD, MGD	X 2015 TOTAL ADD, MGD
DIGHTON	6,175	63.0%	0	16	3,893	0.47	119.6	64.6%	77.7	0.30	24.9%	0.12	10.6%	0.05	7,422	63.04%	4,695	0.36	0.14	0.00	0.00	0.14	0.06	0.56
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	95,739	102.24%	97,886	5.97	6.51	0.15	0.00	6.66	1.40	14.04
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	17,161	102.55%	17,598	1.38	0.62	0.00	0.00	0.62	0.13	2.13
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	28,114	98.14%	27,592	1.91	0.41	0.00	0.00	0.41	0.19	2.51
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	30,418	95.79%	29,137	2.26	0.56	0.06	0.00	0.62	0.32	3.20
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	8,914	110.63%	9,862	0.48	0.17	0.00	0.00	0.17	0.07	0.73
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	14,565	98.32%	14,321	1.13	0.30	0.00	0.00	0.30	0.15	1.58
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	18,327	99.94%	18,316	0.91	0.32	0.00	0.00	0.33	0.10	1.34

2020 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2020 POP PROJECT	P 2020 % SERV POP	Q 2020 SERV POP	R 2020 RES ADD, MGD	S 2020 NON RES ADD, MGD (pop growth)	T 2020 NON RES ADD, MGD (non res growth)	U 2020 NON RES ADD, MGD (constant)	V 2020 TOTAL NON RES ADD, MGD	W 2020 UAW ADD, MGD	X 2020 TOTAL ADD, MGD
DIGHTON	6,175	63.0%	0	16	3,893	0.47	119.6	64.6%	77.7	0.30	24.9%	0.12	10.6%	0.05	7,884	63.04%	4,986	0.39	0.15	0.00	0.00	0.15	0.06	0.59
FALL RIVER	91,938	102.2%	0	0	94,000	13.67	145.4	42.4%	61.0	5.74	45.2%	6.25	12.4%	1.68	97,251	102.24%	99,432	6.07	6.61	0.15	0.00	6.76	1.43	14.26
FOXBORO	16,246	102.5%	0	0	16,660	2.02	121.1	65.8%	78.7	1.31	28.2%	0.59	6.1%	0.12	17,425	102.55%	17,869	1.41	0.63	0.00	0.00	0.63	0.13	2.17
MANSFIELD	22,414	98.1%	0	0	21,998	2.00	90.8	76.1%	69.1	1.52	16.2%	0.32	7.7%	0.16	30,112	98.14%	29,553	2.04	0.44	0.00	0.00	0.44	0.21	2.68
NORTH ATTLEBORO	27,143	95.8%	0	0	26,000	2.91	112.0	69.3%	77.7	2.02	17.2%	0.50	13.5%	0.39	31,552	95.79%	30,223	2.35	0.58	0.06	0.00	0.64	0.33	3.32
PLAINVILLE	7,683	110.6%	0	0	8,500	0.65	76.8	63.3%	48.7	0.41	23.2%	0.15	13.6%	0.09	9,405	110.63%	10,405	0.51	0.18	0.00	0.00	0.18	0.08	0.77
SEEKONK	13,425	98.3%	0	0	13,200	1.46	110.7	71.4%	78.7	1.04	19.0%	0.28	9.6%	0.14	15,002	98.32%	14,751	1.16	0.31	0.00	0.00	0.31	0.16	1.63
SWANSEA	17,359	99.9%	0	0	17,349	1.27	73.3	68.0%	49.9	0.87	24.2%	0.31	7.8%	0.10	18,606	99.94%	18,595	0.93	0.33	0.00	0.00	0.33	0.11	1.36

APPENDIX E-2: 2005 to 2020 WATER SUPPLY NEEDS FORECAST USING MISER DATA - METHOD 2

2005 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2005 POP PROJECT	P 2005 % SERV POP	Q 2005 SERV POP	R POP CHANGE 1998-2005	S 2005 RES. GPCD FACTOR	T 2005 INC. IN RES ADD. MGD	U 2005 INC. IN NON RES ADD, MGD	V 1998-2002 ADD, MGD	W 2005 TOTAL ADD, MGD
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	0.0%	0.00	0.0%	2.36	44,044	94.1%	41,467	1,860	70.0	0.13	0.07	5.19	5.39
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	0.0%	0.00	0.0%	1.72	18,678	94.8%	17,704	421	70.0	0.03	0.18	3.11	3.32
WRENTHAM	10,554	82.8%	0	42	8,734	0.99	113.1	64.1%	99.1	0.87	0.0%	0.00	0.0%	0.12	11,320	82.8%	9,409	676	70.0	0.05	0.01	0.99	1.04

2010 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2010 POP PROJECT	P 2010 % SERV POP	Q 2010 SERV POP	R POP CHANG 1998-2010	S 2010 RES. GPCD FACTOR	T 2010 INC. IN RES ADD, MGD	U 2010 INC. IN NON RES ADD, MGD	V 1998-2000 ADD, MGD	W 2010 TOTAL ADD
ATTLEBORO	42,068	94.1%	0	0	39,607	0.00	0.0	0.0%	71.3	2.82	0.0%	0.00	0.0%	-2.82	45,610	94.1%	42,942	3,335	70.0	0.23	0.13	5.19	5.55
SOMERSET	18,234	94.8%	0	0	17,283	0.00	0.0	0.0%	80.4	1.39	0.0%	0.00	0.0%	-1.39	18,743	94.8%	17,765	482	70.0	0.03	0.33	3.11	3.47
WRENTHAM	10,554	82.8%	0	42	8,734	0.00	0.0	0.0%	99.1	0.87	0.0%	0.00	0.0%	-0.87	11,778	82.8%	9,788	1,055	70.0	0.07	0.02	0.99	1.08

2015 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2015 POP PROJECT	P 2015 % SERV POP	Q 2015 SERV POP	R POP CHANG 1998-2,015	S 2015 RES. GPCD FACTOR	T 2015 INC. IN RES ADD, MGD	U 2015 INC. IN NON RES ADD, MGD	V 1998-2000 ADD, MGD	W 2015 TOTAL ADD
ATTLEBORO	42,068	94.1%	0	0	39,607	0.00	0.0	0.0%	71.3	2.82	0.0%	0.00	0.0%	-2.82	47,650	94.1%	44,862	5,255	70.0	0.37	0.20	5.19	5.76
SOMERSET	18,234	94.8%	0	0	17,283	0.00	0.0	0.0%	80.4	1.39	0.0%	0.00	0.0%	-1.39	19,114	94.8%	18,117	834	70.0	0.06	0.50	3.11	3.67
WRENTHAM	10,554	82.8%	0	42	8,734	0.00	0.0	0.0%	99.1	0.87	0.0%	0.00	0.0%	-0.87	12,254	82.8%	10,182	1,449	70.0	0.10	0.02	0.99	1.11

2020 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2020 POP PROJECT	P 2020 % SERV POP	Q 2020 SERV POP	R POP CHANG 1998-2,020	S 2020 RES. GPCD FACTOR	T 2020 INC. IN RES ADD, MGD	U 2020 INC. IN NON RES ADD, MGD	V 1998-2000 ADD, MGD	W 2020 TOTAL ADD
ATTLEBORO	42,068	94.1%	0	0	39,607	0.00	0.0	0.0%	0.0	2.82	0.0%	0.00	0.0%	-2.82	49,689	94.1%	46,782	7,175	70.0	0.50	0.28	5.19	5.97
SOMERSET	18,234	94.8%	0	0	17,283	0.00	0.0	0.0%	0.0	1.39	0.0%	0.00	0.0%	-1.39	19,484	94.8%	18,468	1,185	70.0	0.08	0.67	3.11	3.87
WRENTHAM	10,554	82.8%	0	42	8,734	0.00	0.0	0.0%	0.0	0.87	0.0%	0.00	0.0%	-0.87	12,749	82.8%	10,550	1,816	70.0	0.13	0.03	0.99	1.14

APPENDIX E-3: 2005 to 2020 WATER SUPPLY NEEDS FORECAST USING MISER DATA - METHOD 1

2005 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2005 POP PROJECT	P 2005 % SERV POP	Q 2005 SERV POP	R 2005 RES ADD, MGD	S 2005 NON RES ADD (pop growth)	T 2005 NON RES ADD, MGD (non res growth)	U 2005 NON RES ADD, MGD (constant)	V 2005 TOTAL NON RES ADD, MGD	W 2005 UAW ADD, MGD	X 2005 TOTAL ADD, MGD	Y LESS THAN 10%	Z GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	29.7%	1.54	15.8%	0.83	44,044	94.1%	41,467	2.96	1.61	0.00	0.00	1.61	0.51	5.07	0.86	0.51
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	45.7%	1.43	9.5%	0.29	18,678	94.8%	17,704	1.42	1.47	0.14	0.00	1.61	0.32	3.35	0.32	0.34
WRENTHAM	10,554	82.8%	0	42	8,734	0.99	113.1	64.1%	72.5	0.63	16.7%	0.13	19.1%	0.19	11,320	82.8%	9,409	0.68	0.14	0.00	0.00	0.14	0.09	0.92	0.20	0.09

2010 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2010 POP PROJECT	P 2010 % SERV POP	Q 2010 SERV POP	R 2010 RES ADD, MGD	S 2010 NON RES ADD, MGD (pop growth)	T 2010 NON RES ADD, MGD (non res growth)	U 2010 NON RES ADD, MGD (constant)	V 2010 TOTAL NON RES ADD, MGD	W 2010 UAW ADD, MGD	X 2010 TOTAL ADD, MGD	Y LESS THAN 10%	Z GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	54.5%	71.3	2.82	19.4%	1.54	11.4%	0.83	45,610	94.1%	42,942	3.06	1.67	0.00	0.00	1.67	0.53	5.25	0.61	0.53
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	44.8%	80.4	1.39	42.5%	1.43	10.3%	0.29	18,743	94.8%	17,765	1.43	1.47	0.29	0.00	1.76	0.35	3.54	0.37	0.35
WRENTHAM	10,554	82.8%	0	42	8,734	0.99	113.1	64.1%	72.5	0.63	16.7%	0.13	18.4%	0.22	11,778	82.8%	9,788	0.71	0.15	0.00	0.00	0.15	0.10	0.95	0.19	0.10

2015 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2015 POP PROJECT	P 2015 % SERV POP	Q 2015 SERV POP	R 2015 RES ADD, MGD	S 2015 NON RES ADD, MGD (pop growth)	T 2015 NON RES ADD, MGD (non res growth)	U 2015 NON RES ADD, MGD (constant)	V 2015 TOTAL NON RES ADD, MGD	W 2015 UAW ADD, MGD	X 2015 TOTAL ADD, MGD	Y LESS THAN 10%	Z GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	69.2%	71.3	2.82	19.4%	1.54	11.4%	0.83	47,650	94.1%	44,862	3.20	1.74	0.00	0.00	1.74	0.55	5.49	0.64	0.55
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	47.2%	80.4	1.39	42.5%	1.43	10.3%	0.29	19,114	94.8%	18,117	1.46	1.50	0.43	0.00	1.93	0.38	3.76	0.39	0.38
WRENTHAM	10,554	82.8%	0	42	8,734	0.99	113.1	64.9%	72.5	0.63	16.7%	0.13	18.4%	0.22	12,254	82.8%	10,182	0.74	0.15	0.00	0.00	0.15	0.10	0.99	0.20	0.10

2020 WATER NEEDS FORECAST

COMMUNITY	A 2000 CENSUS POP	B 2000 SERVICE POP	C 2000 OUT OF TOWN POP	D 2000 SESFACT POP	E 2000 BASE SERVICE POP	F 1998-2002 ADD, MGD	G 1998-2002 AVG GPCD	H 1998-2002 RES. %	I 1998-2002 RES. GPCD	J 1998-2002 RES. ADD, MGD	K 1998-2002 NON RES. %	L 1998-2002 NON RES. ADD, MGD	M 1998-2002 UAW %	N 1998-2002 UAW ADD, MGD	O 2020 POP PROJECT	P 2020 % SERV POP	Q 2020 SERV POP	R 2020 RES ADD, MGD	S 2020 NON RES ADD, MGD (pop growth)	T 2020 NON RES ADD, MGD (non res growth)	U 2020 NON RES ADD, MGD (constant)	V 2020 TOTAL NON RES ADD, MGD	W 2020 UAW ADD, MGD	X 2020 TOTAL ADD, MGD	Y LESS THAN 10%	Z GREATER THAN 10%
ATTLEBORO	42,068	94.1%	0	0	39,607	5.19	131.0	69.2%	71.3	2.82	19.4%	1.54	11.4%	0.83	49,689	94.1%	46,782	3.34	1.82	0.00	0.00	1.82	0.57	5.72	0.66	0.57
SOMERSET	18,234	94.8%	0	0	17,283	3.11	180.2	47.2%	80.4	1.39	42.5%	1.43	10.3%	0.29	19,484	94.8%	18,468	1.49	1.53	0.57	0.00	2.10	0.40	3.98	0.41	0.40
WRENTHAM	10,554	82.8%	0	42	8,734	0.99	113.1	64.9%	72.5	0.63	16.7%	0.13	18.4%	0.22	12,749	82.8%	10,592	0.77	0.16	0.00	0.00	0.16	0.10	1.03	0.21	0.10

APPENDIX F

Water Supply Information

APPENDIX F - Water Supply Information							
Municipality	**Water Supply**	**Safe Yield gpm**	**Safe Yield MGD**	**Permitted 2000 to 2005 MGD**	**Pumping Capacity gpm**	**Pumping Capacity MGD**	**Water Source**
Attleboro			4.4	5.7	5,900	8.50	Groundwater
							Surface water
	Subtotal		**4.4**	**5.7**	**5,900**	**8.50**	
Dighton	Cedar St. Well #1		included	included	123	0.18	Groundwater
	Cedar St. Well #2		0.37	0.37	131	0.19	Groundwater
	Cedar St. Well #3		included	included	293	0.42	Groundwater
	Walker sty. Well #1		0.37	0.37	168	0.24	Groundwater
	Walker sty. Well #2				183	0.26	Groundwater
	Subtotal		**0.74**	**0.74**		**1.29**	
Fall River	Copicant Res.		6.5	6.37	7,361	10.60	Surface water
	N. Watwppa Res.		8.5	8.22	16,667	24.00	Surface water
	S. Watuppa Res.		9				Surface water
	Subtotal		**24**	**14.59**	**24,028**	**34.60**	
Foxboro	Well Nos. 1 & 2A	700	1	0.64	484	0.70	Groundwater
	Well No. 4	400	0.6	0.58	238	0.34	Groundwater
	Well No. 5	400	0.6	0.58	301	0.43	Groundwater
	Well No. 6	400	0.6	0.58	228	0.33	Groundwater
	Well No. 7	250	0.4	0.36	194	0.28	Groundwater
	Well No. 8	150	0.2	0.22	80	0.12	Groundwater
	Well No. 9	400	0.6	0.58	395	0.57	Groundwater
	Well No. 10	500	0.7	0.72	389	0.56	Groundwater
	Well No. 12	325	0.5	0.47	212	0.31	Groundwater
	Well No. 13	500	0.7	0.73	385	0.55	Groundwater
	Subtotal		**5.9**	**5.46**	**2,906**	**4.18**	
Mansfield	Cate Springs No. 1		1.60	included	1,150	1.66	Groundwater
	Prescott No. 8		1.30	2.00	700	1.01	Groundwater
	Prescott No. 9		0.64	included	500	0.72	Groundwater
	Albertini No. 2		0.33	0.33	500	0.72	Groundwater
	Albertini No. 3		0.33	0.33	350	0.50	Groundwater
	Albertini No. 4		0.32	0.32	250	0.36	Groundwater
	Dustin No. 7		1.26	0.86	800	1.15	Groundwater
	Robert E. Walsh		1.50	1.50	1,040	1.50	Groundwater
	Witch Pond No. 6		1.00	1.00	700	1.01	Surface water
	Witch Pond No.10		0.99	0.99	692	1.00	Surface water
	Subtotal		**9.26**	**2.40**	**6,682**	**9.62**	
North Attleborough							Groundwater
							Groundwater
	Subtotal			**2.8**			
Plainville	Well No. 1		0.28	0.28	200	0.29	Groundwater
	Well No. 2		0.28	0.39	200	0.29	Groundwater
	Well No. 3		0.72	0.23	500	0.72	Groundwater
	Well No. 5		0.26	0.26	180	0.26	Groundwater
	Subtotal		**1.54**	**1.16**	1,080	**1.56**	

Rehoboth	**No public water system.**						
Seekonk	171 Brown Ave	300	0.43	0.40	300	0.43	Groundwater
	GP Wel No. 1	650	0.94	1.00	600	0.86	Groundwater
	GP Well No. 2	700	1.01	0.86	500	0.72	Groundwater
	GP Well No. 3	800	1.15	1.15	700	1.01	Groundwater
	GP Well No. 4	600	0.86	0.86	500	0.72	Groundwater
	GP Well No. 5	600	0.86	0.58	400	0.58	Groundwater
	Subtotal		**5.26**	**1.50**	**3,000**	**4.32**	
Somerset	Well #2	403	0.58	0.58	300	0.43	Groundwater
	Somerset Res.	3472	5	4.17	4,167	6.00	Surface Water
	Subtotal		**5.58**	**4.75**	**4467**	**6.43**	
Swansea	Well #1				0	0.14	Groundwater
	Well #2				0	0.14	Groundwater
	Well #3				0	0.11	Groundwater
	Well #4						Groundwater
	Well #5						Groundwater
	Well #6						Groundwater
	Well #7						Groundwater
	Well #8				1	0.72	Groundwater
	Well #9						Groundwater
	Well #10						Groundwater
	Subtotal		**1.5**	**1.5**		**3.50**	
Wrentham	Well #2		0.95	0.95	600	0.86	Groundwater
	Well #3		0.72	0.72	500	0.72	Groundwater
	Well #4		0.66	0.66	500	0.72	Groundwater
	Subtotal		**2.33**	**2.33**	**1,600**	**2.30**	
	Total		**62.42**	**41.5**		**74.5**	

APPENDIX G

MassGIS Datalayer Metadata

~ *MassGIS* ~

Datalayers/GIS Database

Surficial Geology - *October 1999*

Download this layer

OVERVIEW

MassGIS has produced a statewide surficial geology datalayer showing the location of sand and gravel deposits. Originally the data were divided into three panels- west, east, and southeast that correspond to the U.S. Geological Survey 1:250,000 map sheets that were used as a basemap. This datalayer is very generalized when compared to the other MassGIS data. MassGIS uses the surficial geology data only to produce volume or area measurements over a large region, e.g. a drainage basin. It is not accurate for site specific analysis.

As part of a major data development effort, the datalayer has been greatly enhanced. Now panelled by watershed, the data includes areas of fine-grained deposits and floodplains. For the original southeast panel, the 1:250,000 Providence, RI sheet, large sand deposits have also been delineated. Additionally, contour lines indicating depth of sand and gravel deposits have also been added. The coverages are named **SG** and are stored in the WATRSHD2 library.

MANUSCRIPT

This datalayer was interpreted and compiled by Byron Stone, a USGS geologist. A set of USGS 1:250,000 film basemaps were enlarged onto stable based film at a scale of 1:125,000. The data were then recompiled from a set of 1:25,000 quadrangle sheets onto the 1:125,000 basemap. This manuscript does not precisely register with the standard MassGIS basemap.

METHODOLOGY

For the original datalayer production, the tics of the Transverse Mercator manuscripts were projected into the MassGIS State Plane coordinates before digitizing began. Polygons were labeled and a checkplot was made at manuscript scale.

The enhancement, also interpreted and compiled by Byron Stone, was completed in the fall of 1992. With the enlarged maps as basemaps, the fine-grained deposits, floodplains and contours were drafted onto film. All digitizing was completed by MassGIS from these overlays and subsequently, the linework was transformed and projected into state plane coordinates. As with the original manuscripts, these overlays do not precisely register with the MassGIS basemap. Plots were made at a scale of 1:125,000 and compared to the original manuscripts. The coverages were clipped to the 1:100,000 coastline.

In October 1999 this layer was moved from the BASIN library to WATRSHD2 when MassGIS received additional data from Pete Steeves of the USGS office in Northoborough, Mass., that completed the entire extent of all watersheds that cover Massachusetts. At the same time the layer was edited to remove old county lines that remained from a previous tiling scheme.

ATTRIBUTES

Each **SG.PAT** contains the following attributes:

CODE	1 - sand and gravel deposits
	2 - till or bedrock
	3 - sandy till over sand
	4 - end moraines
	5 - large sand deposits where distinguished from sand and gravel deposits
	6 - fine-grained deposits
	7 - floodplain alluvium
AREA-ACRES	Area of the polygon in acres
RANGE	Range of depth of deposit in feet for code = 1 or 5

MAINTENANCE

MassGIS is managing this datalayer.

~ MassGIS ~

Datalayers/GIS Database

Land Use - January 2002

Download this layer

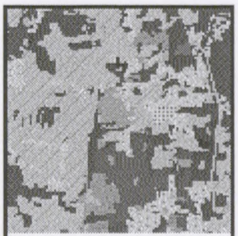
OVERVIEW

The MassGIS Land Use datalayer has 37 land use classifications interpreted from 1:25,000 aerial photography. Coverage is complete statewide for 1971, 1985, and 1999. Additionally, more than half the state was interpreted from aerial photography flown during 1990, 1991, 1992, 1995 or 1997. The 15 towns on Cape Cod also contain land use data for 1951. Please see the Land Use Status Map, which displays the years for which land use data were interpreted for each town. This datalayer is stored in the TOWN library; the layer is named **LANDUSE** and the individual community coverages are named **LUS**.

The year of most recent photography used for land use data interpretation is stored in a single statewide coverage called **LUSTAT**. This layer was necessitated because some towns contain partial coverage for a certain year, which eliminated the one-to-one link between town-ID and year.

NEW: MassGIS has produced **Land Use Summary Statistics**, by municipality, for all three years for which land use is available statewide. These tables summarize acreages for each land use type by year, as well as land use change from 1971 to 1985 and 1985 to 1999.

PRODUCTION



Click to view larger size

Photointerpretation and automation were done by the Resource Mapping Project at the University of Massachusetts, Amherst. The RMP staff aggregated the 104 classes of their original 1971 interpretation into 21 categories and digitized the data into individual community digital coverages using a PC version of Arc/INFO software. The RMP staff then visually compared the 1971 photography and 1985 photography and produced a digital map of only 1971-85 change for each community. Interpretation was made from 1:40,000 9"x 9" color infrared photos flown in Summer 1985. Southeastern Mass was flown in September 1984. The flight and photography were funded by the Massachusetts Dept. of Environmental Management for another project. Several additional categories of land use were added for parts of Massachusetts. Ten communities in the Southeastern Regional Planning & Economic Development District (SRPEDD) west of Buzzards Bay plus Bourne and Falmouth have a total of 28 land use classes. The 28 classes include the original 21 categories plus 23,24,25,26,27,28 and 29 (see Code Definitions below).

In 1990, the Cape Cod Commission funded an update of Cape Cod. These data are categorized into 26 land use classifications, expanding the original codes to include 23,26,29 and 30. These additional codes, along with the original 21, are listed in LU37_CODE. The Massachusetts Water Resources Authority (MWRA) funded land use interpretation in 1991 for 14 towns. The 33 code scheme for this update includes codes 23,24,29,30,31,32,33,34,35,36 and 37 in addition to the original 21 codes. The Executive Office of Transportation and Construction (EOTC) also funded a 1991 update for 113 towns using the same set of codes as the MWRA except for code 37. The UMass RMP staff updated some other towns not included in the 1990-1991 update based on digital orthophotography flown during 1992, 1995, and 1997. The towns that have been updated between 1985 and 1999 are listed below. The minimum mapping unit used was one acre.

Each land use coverage was plotted at a scale of 1:25,000 by the RMP before delivery to MassGIS. MassGIS used a workstation version of Arc/INFO to combine data from different years. Each coverage, therefore, may contain many small polygons that may have been one land use type in, say, 1971. Over the years the land may have been split up for different uses, and the linework in the coverage reflects the land use boundaries for all these uses during the many years of interpretation. Because MassGIS maintains only one coverage per town, the most recent land use code (for 1999) is stored in the polygon's attribute table and the older codes are stored in a "polygon history table". The process of combining the data from different years created some 'sliver polygons'. These result when a theoretically coterminous line in each coverage is actually offset due to it having been digitized twice, e.g. the shore of a lake. Many of these slivers were eliminated by screening for an area/perimeter ratio beyond normal limits.

NOTE: This project was funded by the Massachusetts Executive Office of Environmental Affairs (EOEA), the Executive Office of Transportation and Construction, Massachusetts Water Resources Authority and several regional planning agencies. Photointerpretation and digitizing were completed by the UMASS-Amherst Department of Forestry Resource Mapping Project (RMP).

In 1999, EOEA funded the acquisition of statewide 1:25,000 aerial color infrared photography for use in the latest round of land use interpretation. Again, photointerpretation and digitizing were completed by the UMASS Department of Forestry Resource Mapping Project. As part of the 1999 update RMP staff also removed slivers generated in earlier updates, fine-tuned edgematching between towns, and reinterpreted some historical land use codes.

ATTRIBUTES

Each coverage's Polygon Attribute Table **(LUS.PAT)** contains codes for 1999 land use for each town. Attributes include:

TILE-NAME	Town-ID
LU_ID	Unique polygon ID for the town
LU21_CODE	21 category landuse code for 1999
LU37_CODE	37 category landuse code for 1999

YEAR	Date of most recent data (1999 for all polygons)
RELATE-ID	A redefined item combining the TILE-NAME and LU_ID items. This item uniquely identifies each polygon within the state.

For older land use codes (1951-1997, where interpreted), see the section Historical Land Use.

The polygon attribute table for the **LUSTAT** coverage contains the following items:

TOWN-ID	Town-ID (1 - 351)
TOWN	Town name
ISLAND	1 = Island polygon (a coastal water area sealed off from the ocean)
SRC_CODE	Code of organization that funded a pre-1999 data update (EOTC, MWRA, Cape Cod Commission)
LUYEAR	Date of most recent data (all currently are 1999)
LU_YR_PREV	Date of most recent previous data
UPDATE1999	"Y" if updated to 1999 data, "N" if an older date (all are now coded "Y")
UPDATE1951	"Y" if 1951 data are available (only the 15 Cape Cod towns), "N" if an older date
LUSTAT_LEG	Legend text for intermediate updates (other than 1971, 85, or 99)

LAND USE CODE DEFINITIONS

The two land use code items (LU21_CODE and LU37_CODE) in the polygon attribute and history tables represent two classifications of land use. The 21 category classification aggregates the categories in the 37 category classification as follows:

CODE	ABBREV	CATEGORY	DEFINITION
1	AC	Cropland	Intensive agriculture
2	AP	Pasture	Extensive agriculture
3	F	Forest	Forest
4	FW	Wetland	Nonforested freshwater wetland
5	M	Mining	Sand; gravel & rock
6	O	Open Land	Abandoned agriculture; power lines; areas of no vegetation
7	RP	Participation Recreation	Golf; tennis; Playgrounds; skiing
8	RS	Spectator Recreation	Stadiums; racetracks; Fairgrounds; drive-ins
9	RW	Water Based Recreation	Beaches; marinas; Swimming pools
10	R0	Residential	Multi-family
11	R1	Residential	Smaller than 1/4 acre lots
12	R2	Residential	1/4 - 1/2 acre lots
13	R3	Residential	Larger than 1/2 acre lots
14	SW	Salt Wetland	Salt marsh
15	UC	Commercial	General urban; shopping center
16	UI	Industrial	Light & heavy industry
17	UO	Urban Open	Parks; cemeteries; public & institutional greenspace; also vacant undeveloped land
18	UT	Transportation	Airports; docks; divided highway; freight; storage; railroads
19	UW	Waste Disposal	Landfills; sewage lagoons
20	W	Water	Fresh water; coastal embayment
21	WP	Woody Perennial	Orchard; nursery; cranberry bog
22	-	No Change	Code used by MassGIS only during quality checking

The additional categories in LU37_CODE are:

CODE	ABBREV	CATEGORY
23	CB	Cranberry bog (part of #21)
24	PL	Powerlines (part of #6)
25	RSB	Salwater sandy beach (part of #9; no longer used)
26	RG	Golf (part of #7)
27	TSM	Tidal salt marshes (part of #14; no longer used)
28	ISM	Irregulary flooded salt marshes (part of #14; no longer used)
29	RM	Marina (part of #9)

30	-	New ocean (areas of accretion; part of #20)
31	UP	Urban public (part of #17)
32	TF	Transportation facilities (part of #18)
33	H	Heath (part of #17)
34	CM	Cemeteries (part of #17)
35	OR	Orchard (part of #21)
36	N	Nursery (part of #21)
37	-	Forested wetland (part of #3; no longer used)

All land use categories were aggregated from 104 categories originally defined in 1971. Further information on them can be obtained from Professor William MacConnell at the Dept. of Forestry, University of Massachusetts, Amherst.

HISTORICAL LAND USE

To store the older land use codes, a related "Polygon History table" **(LUS.PHS)** contains the land use for all available years for each polygon. Each town coverage has its own .PHS table (stored in the town tile workspace if you are using coverage data in Librarian format), which relates to its town's .PAT on the redefined item RELATE-ID (a unique id comprising TILE-NAME and LU_ID). A statewide version of the LUS.PHS table is also maintained and is stored in the Town library's 'database' workspace. When distributing data as export files, the LUS<town-id>.PHS is included in the .e00 file. Shapefile .exe files contain the town-based .PHS table named lus<town-id>ph.dbf.

The **LUS.PHS** table contains the following items:

AREA	In square meters
PERIMETER	In meters
TILE-NAME	Town-ID
LU_ID	Unique polygon ID for the town
LU21_CODE	21 category landuse code (for YEAR)
LU37_CODE	37 category landuse code (for YEAR); Code will be same as LU21_CODE for pre-1990 data (except 10 SRPEDD towns for 1985, as noted above).
YEAR	Date of historical data (Year of photography used in land use compilation - 1951, 1971, 1985, 1990, 1991, 1992, 1995, 1997, 1999)
RELATE-ID	A redefined item combining the TILE-NAME and LU_ID items. This item uniquely identifies each polygon within the state. In shapefile versions of the .PHS files this item is named RELATE_ID and is not redefined.

Using the .PHS Tables

Here is an example of how to join a coverage .PAT to the .PHS table to determine historical land use, using town #105 (Georgetown) as an example. **In the LUS.PAT** we find this record (polygon 355, indicated by the LU_ID item):

TILE-NAME	LU_ID	LU37_CODE	LU21_CODE	YEAR	RELATE-ID
105	355	32	18	1999	105 355

The RELATE-ID (highlighted in yellow) is this polygon's unique record within the state. Since land use data for Georgetown has been interpreted during four years, there are four records for each polygon in the LUS.PHS table - one for each year for which land use has been recorded (1971, 1985, 1991, and 1999). Using the RELATE-ID as our common field we can relate **to the LUS.PHS table**, where we find these four corresponding records:

TILE-NAME	LU_ID	LU37_CODE	LU21_CODE	YEAR	RELATE-ID
105	355	3	3	1971	105 355

105	355	2	2	1985	105	355
105	355	32	18	1991	105	355
105	355	32	18	1999	105	355

Once this relate is established, you may determine the landuse codes for this polygon for 1971, 1985, and 1991. In the example above, polygon 355 was coded 3 (forest) in 1971, 2 (pasture) in 1985, and 18 (transportation) in 1991. Also found here are the codes for 1999, which match the codes in the .PAT. Because the 37 classification codes are available only for post-1985 landuse data, the more specific code 32 (transportation facility) is used for the LU_37 item, whereas 18 (transportation) is used for LU21_CODE in the record where YEAR = 1991. Accordingly, the records for 1971 and 1985 show no difference between LU37_CODE and LU21_CODE within each year.

Important notes when joining to the historical land use tables:
- When using the .PHS table in workstation ArcInfo (e.g. ArcPlot), use the RESELECT command to select a particular YEAR prior to establishing a relate.
- In ArcGIS 8x, ArcView 3x, or other GIS software, users may need to select the .PHS records for a particular year, export the selected records to a new table, alter column names, and then join the polygons to the subset of the .PHS. This is to ensure that joined fields and polygon attribute table fields will have unique, distinguishable names, since both the .PAT and the .PHS use the same field names (LU21_CODE and LU37_CODE) to store land use codes.

Download the Statewide history table (self-extracting .exe file, 3.2 megabytes - once downloaded, double-click on the file in Windows Explorer to extract the lusphs.dbf file). As mentioned above, individual town-based history tables are included in each town's export file or shapefile .exe file, available from the Land Use Download page.

UPDATED LAND USE

All towns have been updated to include 1999 land use codes by UMass-Amherst.

The following towns have been updated by UMass-Amherst using orthophotography flown during the years listed in parentheses:

ADAMS(1997)
ASHBURNHAM (1997)
ASHBY (1997)
ASHFIELD (1997)
ATHOL (1997)
BERNARDSTON (1997)
BUCKLAND (1995)
CHARLEMONT (1997)
COLRAIN (1997)
CONWAY (1997)
DEERFIELD (1997)
ERVING (1997)
FLORIDA(1997)
GARDNER (1997)
GILL (1997)
GOSHEN (1997)
GRANBY (1997)
GREENFIELD (1997)
HADLEY (1997)
HATFIELD (1997)
HAWLEY (1997)
HEATH (1997)
HUBBARDSTON (1992, 1997)
LEYDEN(1997)
MONROE (1997)
MONTAGUE (1997)
NEW SALEM (1992)
NORTH ADAMS (1997)
NORTHAMPTON (1997)
NORTHFIELD (1997)
ORANGE (1997)
PETERSHAM (1992)
PHILLIPSTON (1992, 1997)
PLAINFIELD (1997)
ROWE (1997)
ROYALSTON (1997)
SAVOY (1997)
SHELBURNE (1995, 1997)
SOUTHWICK (1997)
SUNDERLAND (1997)
TEMPLETON (1992, 1997)
WARWICK (1997)
WENDELL (1992, 1997)
WESTMINSTER (1992, 1997)
WINCHENDON (1997)

The following is a list of town IDs and names for which 1990/1991 land use is available. The organization that completed the updates is listed in parentheses.

1 ABINGTON (EOTC)
2 ACTON (EOTC)
7 AMESBURY
83 EAST BRIDGEWATER (EOTC)
86 EASTHAM (CAPE)
174 MAYNARD (EOTC)
175 MEDFIELD (EOTC)
176 MEDFORD (MWRA)
258 SALEM (EOTC)
259 SALISBURY (EOTC)
261 SANDWICH (CAPE)

(EOTC)
9 ANDOVER (EOTC)
10 ARLINGTON (MWRA)
14 ASHLAND (EOTC)
16 ATTLEBORO (EOTC)
18 AVON (EOTC)
19 AYER (EOTC)
20 BARNSTABLE (CAPE)
23 BEDFORD (EOTC)
25 BELLINGHAM (EOTC)
26 BELMONT (MWRA)
28 BERLIN (EOTC)
30 BEVERLY (EOTC)
31 BILLERICA (EOTC)
32 BLACKSTONE (EOTC)
34 BOLTON (EOTC)
35 BOSTON (MWRA)
36 BOURNE (CAPE)
37 BOXBOROUGH (EOTC)
38 BOXFORD (EOTC)
40 BRAINTREE (EOTC)
41 BREWSTER (CAPE)
42 BRIDGEWATER (EOTC)
44 BROCKTON (EOTC)
46 BROOKLINE (MWRA)
48 BURLINGTON (EOTC)
49 CAMBRIDGE (MWRA)
50 CANTON (EOTC)
51 CARLISLE (EOTC)
52 CARVER (EOTC)
55 CHATHAM (CAPE)
56 CHELMSFORD (EOTC)
57 CHELSEA (MWRA)
64 CLINTON (EOTC)
65 COHASSET (EOTC)
67 CONCORD (EOTC)
71 DANVERS (EOTC)
73 DEDHAM (EOTC)
75 DENNIS (CAPE)
78 DOVER (EOTC)
79 DRACUT (EOTC)
81 DUNSTABLE (EOTC)
82 DUXBURY (EOTC)
88 EASTON (EOTC)
92 ESSEX (EOTC)
93 EVERETT (MWRA)
96 FALMOUTH (CAPE)
99 FOXBOROUGH (EOTC)
100 FRAMINGHAM (EOTC)
101 FRANKLIN (EOTC)
105 GEORGETOWN (EOTC)
107 GLOUCESTER (EOTC)
115 GROTON (EOTC)
116 GROVELAND (EOTC)
118 HALIFAX (EOTC)
119 HAMILTON (EOTC)
122 HANOVER (EOTC)
123 HANSON (EOTC)
125 HARVARD (EOTC)
126 HARWICH (CAPE)
128 HAVERHILL (EOTC)
131 HINGHAM (EOTC)
133 HOLBROOK (EOTC)
136 HOLLISTON (EOTC)
138 HOPEDALE (EOTC)
139 HOPKINTON (EOTC)
141 HUDSON (EOTC)
142 HULL (EOTC)
144 IPSWICH (EOTC)
145 KINGSTON (EOTC)
146 LAKEVILLE (EOTC)
147 LANCASTER (EOTC)
149 LAWRENCE (EOTC)
155 LEXINGTON (EOTC)
157 LINCOLN (EOTC)
158 LITTLETON (EOTC)
160 LOWELL (EOTC)
163 LYNN (EOTC)
164 LYNNFIELD (EOTC)
165 MALDEN (EOTC)
166 MANCHESTER (EOTC)
167 MANSFIELD (EOTC)
168 MARBLEHEAD (EOTC)
170 MARLBOROUGH (EOTC)
171 MARSHFIELD (EOTC)
172 MASHPEE (CAPE)
177 MEDWAY (EOTC)
178 MELROSE (EOTC)
179 MENDON (EOTC)
180 MERRIMAC (EOTC)
181 METHUEN (EOTC)
182 MIDDLEBOROUGH (EOTC)
184 MIDDLETON (EOTC)
185 MILFORD (EOTC)
187 MILLIS (EOTC)
188 MILLVILLE (EOTC)
189 MILTON (EOTC)
196 NAHANT (EOTC)
198 NATICK (EOTC)
199 NEEDHAM (EOTC)
205 NEWBURY (EOTC)
206 NEWBURYPORT (EOTC)
207 NEWTON (EOTC)
208 NORFOLK (EOTC)
210 NORTH ANDOVER (EOTC)
211 NORTH ATTLEBOROUGH (EOTC)
213 NORTH READING (EOTC)
215 NORTHBOROUGH (EOTC)
216 NORTHBRIDGE (EOTC)
218 NORTON (EOTC)
219 NORWELL (EOTC)
220 NORWOOD (EOTC)
224 ORLEANS (CAPE)
229 PEABODY (EOTC)
231 PEMBROKE (EOTC)
232 PEPPERELL (EOTC)
238 PLAINVILLE (EOTC)
239 PLYMOUTH (EOTC)
240 PLYMPTON (EOTC)
242 PROVINCETOWN (CAPE)
243 QUINCY (EOTC)
244 RANDOLPH (EOTC)
245 RAYNHAM (EOTC)
246 READING (EOTC)
248 REVERE (EOTC)
251 ROCKLAND (EOTC)
252 ROCKPORT (EOTC)
254 ROWLEY (EOTC)
262 SAUGUS (EOTC)
264 SCITUATE (EOTC)
266 SHARON (EOTC)
269 SHERBORN (EOTC)
270 SHIRLEY (EOTC)
274 SOMERVILLE (MWRA)
277 SOUTHBOROUGH (EOTC)
284 STONEHAM (MWRA)
285 STOUGHTON (EOTC)
286 STOW (EOTC)
288 SUDBURY (EOTC)
291 SWAMPSCOTT (EOTC)
293 TAUNTON (EOTC)
295 TEWKSBURY (EOTC)
298 TOPSFIELD (EOTC)
300 TRURO (CAPE)
301 TYNGSBOROUGH (EOTC)
303 UPTON (EOTC)
304 UXBRIDGE (EOTC)
305 WAKEFIELD (MWRA)
307 WALPOLE (EOTC)
308 WALTHAM (MWRA)
314 WATERTOWN (EOTC)
315 WAYLAND (EOTC)
317 WELLESLEY (EOTC)
318 WELLFLEET (CAPE)
320 WENHAM (EOTC)
322 WEST BRIDGEWATER (EOTC)
324 WEST NEWBURY (EOTC)
328 WESTBOROUGH (EOTC)
330 WESTFORD (EOTC)
333 WESTON (EOTC)
335 WESTWOOD (EOTC)
336 WEYMOUTH (EOTC)
338 WHITMAN (EOTC)
342 WILMINGTON (EOTC)
344 WINCHESTER (MWRA)
346 WINTHROP (EOTC)
347 WOBURN (MWRA)
350 WRENTHAM (EOTC)
351 YARMOUTH (CAPE)

MAINTENANCE

MassGIS is maintaining this layer. The Land Use Status Map displays the years for which land use data were interpreted.

Last Updated 9/23/2003

~ MassGIS ~

Datalayers/GIS Database

Major Ponds and Major Streams - July 1998

Download these layers

OVERVIEW

The Major Ponds and Major Streams datalayers represent a subset of hydrographic features from the 1:100,000 Basin-tiled HD100 layer. Large water bodies and rivers are included in these two layers, respectively, and are meant to be used for plotting small-scale maps. Both are stored as single statewide datasets: **MAJ_POND** and **MAJ_STRM**.

PRODUCTION

The data were taken from the more detailed 1:100,000 hydrography layer, which was developed from the US Geological Survey's National Marine Division 1:100,000 digital line graphs (DLGs). The determination of which features should be considered "major" was made by M. Frimpter, Chief Hydrologist for the USGS.

ATTRIBUTES

The MAJ_POND layer has a polygon attribute table (.PAT) with the following items:

TYPE	Hydrographic feature type: (character item, 2-2-C) P = Pond, DS = Doubleline River, I = Island
FEATURE	Hydrographic feature type: (numeric item, 2-2-B) 1 = Pond, 2 = Doubleline River, 3 = Island
PRIMARY	Place-holder; codes have no meaning

The MAJ_STRM layer has an arc attribute table (.AAT) with the following item:

PRIMARY	All arcs are streams coded as 1

MAINTENANCE

MassGIS is maintaining these layers.

~ MassGIS ~

Datalayers/GIS Database

Drainage Sub-basins - August 2003

Download this layer

OVERVIEW

MassGIS has produced a statewide digital datalayer of the approximately 2300 sub-basins as defined and used by the USGS Water Resources Division and the Mass Water Resources Commission and as modified by Executive Office of Environmental Affairs (EOEA) agencies. These sub-basins were aggregated together to make the 28 basins of the Major Basins Datalayer. Cape Cod and the Islands do not have much lateral 'surface' drainage because the soils are so porous. The sub-basin line shown for Cape Cod is the approximate groundwater divide between Cape Cod Bay, Vineyard Sound, and the Atlantic Ocean, taken from sub-surface groundwater contours. The state coastline and boundaries are included in the sub-basin coverages and are differentiated by arc attributes. The sub-basin datalayer is stored in the Basin library. Coverages are named SUBBAS.

MANUSCRIPT

A set of 1:24,000 USGS paper quad sheets was delineated into approximately 2200 minor or drainage sub-basins. This work was produced over the past 20 years mainly by the USGS-WRD. Generally, the contours on the quads are the primary guide to basin boundaries. Often the 'mouth' of a basin is marked at the site of a stream gaging station, which can be different from the strict geographic location of the mouth.

METHODOLOGY

All sub-basins on the manuscripts were digitized. Due to good manuscript quality, including the visual edgematching of the 189 sheets, digitizing and edgematching was straightforward. The manuscript author was consulted on the minor errors and ambiguities that were discovered.

Drainage boundaries added to Cape Cod were created by the Massachusetts Bays Program (the boundary separating drainage between Nantucket Sound/Cape Code Bay/Atlantic Ocean) and the Buzzards Bay Project (the boundary separating drainage between Buzzards Bay and Nantucket Sound/Cape Code Bay). The subdivisions were created by delineating groundwater divides using the 1:48,000 scale USGS Hydrologic Atlas Series maps. The delineations were reviewed for consistency by the USGS Water Resources Division, but they are not considered official basins of the USGS or the MA Water Resources Commission.

In the fall of 1992 the MA Department of Environmental Protection Division of Water Supply added the state boundary and 1:100,000 coastline and extended or clipped the sub-basins to meet them. Additional drainage basins were delineated at the intake points of public water supplies. From these additional basins all upstream basins were coded as contributing to a surface public water supply. DEP regional staff determined which water supplies were primary and which were emergency or backup supplies, and the MDC provided the basins covered by MDC/MWRA jurisdiction.

ATTRIBUTES

Each drainage sub-basin has a unique 5 digit SUB-ID number that was derived from the numbering system on the manuscripts. The numbers are roughly hierarchically ordered based on the sub-basin's position within the major basin. The ID-numbers ascend as the water descends. The first two numbers in the 5 digit code identify the 28 major basins as numbered in Massachusetts (see listing in the Major Basins Datalayer Description). This 2 digit code is duplicated in the (redefined) MAJ_BAS ITEM. The last three numbers in the **SUB-ID** are duplicated in the **(redefined) POSITION** ITEM. Offshore islands are given a **SUB-ID** of ##999 where ## is the nearest onshore **MAJ_BAS** ID.

The surface Water supply attribute, **WSP** is coded as follows:

WSP	BASIN DESIGNATION
0	Sub basin does not contribute to a Public Surface Water Supply
1	Public Surface Water Supply Watershed
2	Emergency/Backup Public Surface Water Supply Watershed
3	Adjacent State Surface Water Supply Watershed (incomplete)
4	MDC/MWRA Watershed
5	MDC/MWRA and Public Surface Water Supply Watershed

The arcs are coded with the two digit attribute **LINE-ID**, which identifies the type of boundary the line represents:

LINE-ID	LINE TYPE
0	Sub-Basin Boundary
1	Major Basin Boundary
2	Coastline or State Boundary

EDITING

The entire datalayer was plotted at 1:100,000, selected areas at 1:25,000. Edgematching was done. The manuscript often had more than one ID per sub-basin. One was chosen by MassGIS. The water supply designation was plotted and checked by DEP regional staff.

MAINTENANCE

This datalayer is maintained by MassGIS and the DEP GIS Group. Tile 6 was modified by the DEP GIS Group in September, 2001. Tiles 1 and 5 required linework updates in February, 2002, as a result of updates to the DEP Surface Water Supply Protection Area (Zone A, B, C) layers. In May, 2002, the DEP GIS Group made Linework/Poly edits to existing sub-basin boundaries for tiles 3 and 5 and Polygon attribute updates to WSP field for tiles 1, 6, and 9. In July, 2002, DEP GIS made similar updates to tiles 1, 5, 6, and 8. In September, 2002, DEP GIS similarly updated tile 6. In November, 2002, tiles 1, 5, 6, 7 and 9 had polygon attribute updates to WSP. In December, 2002, two sub-basins were added (19301 and 13067) as a result of modifications to DEP SWPA ZoneC for Public Water Supplies 3040000-02S and 3128000-01S. In March, 2003, tiles 1 and 3 had linework updates and tiles 5,6,7,8 and 9 had attribute (WSP) updates. In August, 2003, tile 13 was updated.

~ MassGIS ~

Datalayers/GIS Database

Public Water Supplies - November 2003

Download this layer

OVERVIEW

The Public Water Supply (PWS) datalayer (coverage and layer are named **PWS_DEP**) contains the locations of public community surface and groundwater supply sources and public non-community supply sources as defined in 310 CMR 22.00. The public water supply systems represented in this datalayer are based primarily on information in the DEP's Water Quality Testing System (WQTS) database. The WQTS database is the Department's central database for tracking water supply data. The PWS datalayer also contains the locations of proposed wells that have a defined DEP approved wellhead protection area (Zone IIs). Proposed sources are not currently tracked in WQTS.

Massachusetts Drinking Water Regulations (310 CMR 22.00)

As stated in 310 CMR 22.02, a Public Water System means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days of the year. Such term includes (1) any collection, treatment, storage and distribution facilities under control of the operator of such a system and used primarily in connection with such system, and (2) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. A public water system is either a "community water system" or a "non-community water system."

(a) Community water system means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.
(b) Non-community water system means a public water system that is not a community water system.

1. Non-transient non-community water system or "NTNC" means a public water systems that is not a community water system and that regularly serves at least 25 of the same persons or more approximately four or more days per

week, more that six months or 180 days per year, such as a workplace providing water to it's employees.

2. Transient non-community water system or "TNC" means a public water system that is not a community water system or a non-transient non-community water system but is a public water system which serves water to 25 different persons at least 60 days of the year. Some examples of these types of systems are: restaurants, motels, camp grounds, parks, golf courses, ski areas and community centers.

DATA DEVELOPMENT

The DEP PWS datalayer has been compiled from several sources. The original DEP PWS point dataset contained only community water supplies (CWS) which were located and digitized from stable mylar overlays based on USGS topographic quadrangles. In 1993 locations for community and non-community sources were generated from global positioning system (GPS) data collected by the U.S. Environmental Protection Agency (EPA). The EPA GPS locations were merged with the existing DEP CWS point data to create the DEP PWS datalayer. From June 1996 to February 1997 the DEP GIS Program and Drinking Water Program (DWP) conducted an intensive update of the PWS datalayer. This update involved several methodologies including map interpolation and GPS field verification.

ATTRIBUTES

The **PWS_DEP** datalayer has a point attribute table (.PAT) with the following items:

General Identification Fields:

SOURCE-ID	DWP assigned PWS source identifier (first 7 digits conform to PWSID). The SOURCE-ID is used to relate PWS source locations to WQTS and other DEP PWS datalayers. (see Related Datalayers section below)
SITE-NAME	For community sources this is the source name (S_NAME) as listed in WQTS, for non-community sources this is the public water supply name (PWS_NAME) as listed in WQTS. For proposed sources, which are not tracked in WQTS, this is the source name as listed in DEP DWP's Zone II database (see Related Database Files section below).

Geographic Information Fields:

TOWN	Town in which the source is loacted
DEP-ID	DEP Region code (1 = Western, 2 = Central, 3 = Northeast, 4 = Southeast)
LATITUDE	Latitude in decimal degrees, Clarke1866 Spheroid, NAD27 (actual)
LONGITUDE	Longitude in decimal degrees, Clarke1866 Spheroid, NAD27 (actual)

Other Fields:

TYPE	The type of PWS according to WQTS or the DWP Zone II database: ESW = Emergency Surface Water, GW = Community groundwater well, SW = Community surface water source, PW = proposed well, NTNC = Non-Transient Non-community, TNC = Transient Non-Community.
ZII-NUM	DEP DWP assigned ID number of Zone II associated with the source. Corresponds to the ZII-NUM item in the region subclass table (ZONE_II.PATZONE2) of the ZONE_II datalayer

RELATED DATALAYERS

The **PWS_DEP** datalayer should always be used in association with the following related DEP water supply protection datalayers:

DEP Approved Wellhead Protection Areas (Zone II)

PWS sources with assigned Zone IIs are related to the Zone II datalayer's Zone2 region subclass table by the item ZII-NUM (see: PWS_DEP.PRL). Please note that in most cases there are more than one PWS source per Zone II.

DEP Interim Wellhead Protection Areas (IWPA, IWPACOM)
Although there is no database relate between the PWS sources and the IWPA datalayer, it is important to always display IWPAs with DEP PWS point data on any map or project. The IWPA data is a simple Arc/INFO polygon coverage generated from buffering the PWS source locations based on pumping rate or DEP default values.

DEP Surface Water Supply Protection Areas (Zone A, Zone B, Zone C)
DEP Zone A and Zone B surface water supply protection areas are related to the PWS source data by SOURCE-ID.

RELATED DATABASE TABLES

Several relatable database files are provided for the purpose of linking DEP PWS source locations with more detailed PWS attribute information and to provide standard DEP GIS metadata. Files are also provided for relating to the MassGIS drainage sub-basins datalayer, for the purpose of defining the contributing watersheds for DEP PWS surface water sources. The attached INFO file PWS_DEP.PRL contains the relate environment for the PWS datalayer.

PWS_DEP.WQTS

The PWS_DEP.WQTS table contains information downloaded from the DWP Water Quality Testing System (WQTS) Oracle database. WQTS is DEP's comprehensive repository for PWS information. The WQTS database contains many other data items that are not in the PWS_DEP.WQTS relate file. This table was designed for use by the DEP GIS Program to maintain the PWS datalayer in close relation to WQTS. Current items include:

PWSID	DEP water supplier identification number
PWS_NAME	Water supplier name – conforms to SITE-NAME for non-community sources
PWS_CLASS	Source classification: COM = Community surface and groundwater sources, NTNC = Non Transient Non Community, NC = Transient Non Community
PWS_STATUS	Water supplier status (A = Active, I = Inactive)
SOURCE-ID	PWS source Identification number
S_NAME	Source name, conforms to SITE-NAME for community sources
S_STATUS	Source status (A = Active, I = Inactive)
S_AVAILABI	Source availability (ACTIVE, INACT, EMERG, ABAND), abandoned (ABAND) sources are NOT maintained in PWS_DEP

Only sources coded in WQTS as having Active (ACTIVE), Inactive (INACT) or Emergency (EMERG) availability (see: S_AVAILABI field) are maintained in PWS_DEP. As stated in 310 CMR 22.02:

1. An Active Source means an approved source(s) used for primary or backup purposes to meet consumer demands as necessary.
2. An Inactive source means an approved source(s) which is expected to be off-line for at least one year (12 months). A source may be deemed inactive only upon written approval of the Department…
3. An Emergency source means any source of water used to

supplement or temporarily replace a public water system's active or inactive source(s) when water of sufficient quality or quantity is not available…

Sources listed as abandoned (ABAND) in WQTS are removed from the PWS datalayer. Sources in WQTS that are coded as abandoned include both abandoned and decommissioned wells. Abandoned sources are no longer in use or are otherwise unfit for the purposes of water supply. Abandoned sources have been physically disconnected from the distribution system but have not undergone DEP's formal decommissioning process. Decommissioning requires physically rendering the source incapable of water supply delivery.

PWS_DEP.Z2DAT

The PWS_DEP.Z2DAT table contains information from the DEP DWP Zone II Tracking database. Items include:

TOWN	Town in which the PWS source is located
WELLNAME	Source name
PURVEYOR	Water supplier name
BASIN	Major drainage basin in which the PWS source is located
REGION	DEP Region identification number: 1 = Western, 2 = Central, 3 = Northeast, 4 = Southeast
SOURCE-ID	DEP PWS source ID (see:SOURCE-ID description for PWS_DEP.PAT)
ZII-NUM	DEP DWP assigned ID of the Zone II protecting a source(s)
METHOD	Method in which the Zone II was delineated
AQUIFER	Type of aquifer that comprises the Zone II
PROGRAM	DEP DWP program under which the Zone II was approved
SUB_DATE	Date the Zone II was submitted to DEP DWP for approval
APP_DATE	Date that the Zone II was approved
RATE_GPM	Source pumping rate in gallons per minute (GPM)
STATUS	Current Zone II status (C = Current, S = Superseded)
SYSTEM	PWS Classification (COMM = Community, NC = Non Community, N/A
WHP_CNTRL	Existing wellhead protection plan (Y = Yes, N = No)
BYLAW_DATE	Date of Bylaw approvalcontaining well head protection plan

PWS_DEP.SWP-BASINS

The PWS_DEP.SWP-BASINS table links PWS surface water supply (SW) sources to the MassGIS drainage sub-basins datalayer using the item SUB-ID. Items include:

SOURCE-ID	DEP PWS source ID (see:SOURCE-ID description for PWS_DEP.PAT)
REG_OBJ_ID	DEP Facility MasterFile (FMF) Regulated Object ID – Unique Identifier
SUB-ID	Drainage sub-basin identification number that contributes to the surface water supply
Redefined items:	
REGION	DEP Region identification number in which the surface water supply intake is located: 1 = Western; 2 = Central 3; = Northeast; 4 = Southeast
TOWN-ID	MassGIS town identification number in which the surface water supply intake is located
BAS-ID	MassGIS major drainage basin identifier (see: Major Drainage Basins) in which the surface water supply intake is located
PWSID	DEP public water supplier or system identification number (First 4 digits are DEP Region ID followedby MassGIS Town ID)

PWS_DEP.DRS-BASINS

The PWS_DEP.DRS-BASINS table links direct river sources to the MassGIS drainage sub-basins datalayer using the item SUB-ID. Direct River Sources (DRS) are PWS surface water supplies with intakes located on Class B rivers. Items include:

SOURCE-ID	DEP PWS source ID (see:SOURCE-ID description for PWS_DEP.PAT)
SUB-ID	Drainage sub-basin identification number that contributes to the surface water supply

Redefined items:

REGION	DEP Region identification number in which the surface water supply intake is located: 1 = Western, 2 = Central, 3 = Northeast, 4 = Southeast
TOWN-ID	MassGIS town identification number in which the surface water supply intake is located
BAS-ID	MassGIS major drainage basin identifier (see: Major Drainage Basins data layer documentation) in which the surface water supply intake is located
PWSID	DEP public water supplier or system iden. number (First 4 digits are DEP Region ID, followed by MassGISTown ID)

DEP Location Documentation Table (.ldt)

The location documentation table (**PWS_DEP.LDT**) contains standard DEP data documentation fields.

FIELD	TYPE / WIDTH	DEFINITION
RTN	C / 9	BWSC ReleaseTracking Number (RTN) - unique site ID
L_BASE	C / 3	Base map type code
L_ACC_EST	I / 4	Location accuracy estimate measurement
L_TYPE	C / 4	Location type code
L_METH	C / 4	Location method code
L_SRC_1	C / 30	Primary source material code
L_SRC_2	C / 30	Secondary source material code
L_SRC_3	C / 30	Tertiary source material code

Item descriptions:

L_BASE (Location Base Map)

The standard MassGIS base map is the 1:5,000 digital orthophotography (DOQ). Point data development at DEP should whenever possible conform to the 1:5,000 standard. Since DEP has significant historical data developed at smaller scales (1:24,000 and 1:25,000), it is important that base scale be documented. The L_BASE field contains a code that represents both the type of base map and/or the technique used for digitizing the location. Current DEP location accuracy estimate codes are as follows:

CODE	DEFINITION
DOQ	Digitized on screen using digital orthophoto base map (DOQ)
DTQ	Digitized on screen from USGS digital topographic quadrangle (DTQ)
DVB	Digitized on screen using digital vector base (DVB) map
NA	Not applicable (NA), automation based on address match technique or coordinate input from sources such as external database or GPS.
PTQ	Digitized from USGS paper topographic quadrangle, or stable mylar-based overlay manuscript compiled on USGS topographic quadrangle, using traditional tablet digitizing technique

L_ACC_EST (Location Accuracy Estimate)

Horizontal accuracy refers to the quantitative measurement of the deviation from a coordinate position to the actual position (on the ground) that the coordinate represents. The DEP's horizontal accuracy goal for point locations is +/-16.4 feet (approx. 5m). This goal reflects the accuracy capabilities of the DEP's GeoExplorer (GPS) receivers, which under optimal mapping conditions are capable of providing horizontal accuracy typically in the order of 2-5 meters. The DEP's horizontal accuracy goal exceeds the +/-25 meter (approx. 82ft) horizontal accuracy goal recommended by the EPA's Locational Accuracy Task Force (LATF). Like the EPA's recommended accuracy goal (+/-25m), it is important to remember that DEP's accuracy goal (+/-16.4m) is simply a goal and not a standard. Most DEP point locations are estimated to be within +/-100 feet (30.5m), and the coarsest allowable horizontal accuracy for DEP production data is +/-1,000 feet (approx. 305m). The L_ACC_EST field contains an integer value representing the estimated horizontal accuracy of the location in feet, according to the data developer. Common DEP location accuracy estimate values include:

VALUE	DEFINITION
16	Estimated horizontal accuracy is +/-16ft (5m)
100	Estimated horizontal accuracy is+/-100 ft (30.5m)
500	Estimated horizontal accuracy is+/-500 ft (152.4m)
1000	Estimated horizontal accuracy is+/-1000 ft (305m)

L_TYPE (Location Type)

The location type (L_TYPE) field contains a spatial reference code, indicating what the point represents. Current DEP location type codes are as follows (others may be added as required):

CODE	DEFINITION
RS	Approximate centroid of PWS reservoir polygon
EL	Estimated location
GW	Approximate location of public water supply (PWS) groundwater well
PH	Pump House associated with PWS
SW	Approximate location of PWS surface water intake
WF	Approximate center of a well field

L_METH (Location Method)

The location method (L_METH) field contains an alphanumeric code defining the method used to locate the feature. The location method is determined by the primary source used. Current DEP location method codes are as follows (others may be added as required):

Address Matched:

CODE	DEFINITION
AM_1	Address matched to address numberand street
AM_2	Address matched to nearest intersection
AM_3	Address matched to midpoint of street segment centerline

Digital Data:

CODE	DEFINITION
DD_1	Location snapped to point feature in an existing digital dataset
DD_2	Location snapped to the centroid of an existing area digital dataset
DD_3	Location derived from external digital data source but not snapped to feature.

Global Positioning System (GPS):

CODE	DEFINITION
GP_1	Feature located using GPS Survey Grade Carrier Phase Signal Data
GP_2	Feature located using GPS Coarse Acquisition Code: Differentially Corrected
GP_3	Feature located using GPS Coarse Acquisition Code: Real Time Corrected
GP_4	Feature located using GPS Coarse Acquisition Code: Uncorrected; positions averaged
GP_5	Feature located using GPS Coarse Acquisition Code: Uncorrected; single position
GP_6	Feature located using GPS: Unspecified Device; DGPS Unknown

Interpolation:

CODE	DEFINITION
IN	Interpolation based on primary source material (L_SRC_1)

Coordinate Generated:

CODE	DEFINITION
XY_1	Coordinate pair derived from traditional survey techniques
XY_2	Coordinate pair reported by DEPstaff derived from (1:5,000) Orthophotography
XY_3	Coordinate pair reported by DEP staff derived from (1:25,000) USGS topographic map
XY_4	Coordinate pair unverified or reported by regulated community; includes undocumented coordinate data from DEP programmatic databases

L_SRC_1,2,3 (Location Source)

The L_SRC_1 field contains a code indicating the primary source material used to locate the feature. The L_SRC_2 field contains a code that indicates the secondary source material used to locate the feature. The L_SRC_3 field contains a code that indicates any tertiary source material used to locate the feature. Current DEP source codes are as follows (others may be added as required):

Database Sources (for Coordinate or Address Data)

Database source code indicates database and/or data provider.

DB_<Source> Standard database source codes currently include:

BOE	Massachusetts Board of Education
BOH	Massachusetts Board of Health
EPICS	DEP Environmental Protection IntegratedComputer System
EPA	US EnvironmentalProtection Agency
DFS	Massachusetts Department of FireServices (DFS)
SSEIS	DEP BWP Stationary Source EmissionInventory System
WMA	DEP BRP WPP Water Management Act
WPP	DEP Water Permitting Program Database

Digital Data Sources

Digital data source code indicates digital datalayer and/or data provider.

DD_<Source> Standard digital data source codes currently include:

21E	DEP BWSC Chapter 21E Tier Classified Oil or Hazardous Materials datalayer
BAS	MassGIS watershed/basin data
FAC	DEP BWP Regulated Facilities datalayer
GWP	DEP Permitted Discharge to Groundwater datalayer
LU	MassGIS Land Use datalayer
MMR	Massachusetts Military Reservation
NPDES	DEP NPDES datalayer
NPL	US EPA National Priority List datalayer
OS	MassGIS Open Space datalayer
PAR	Digital Parcel Data
PWS	DEP Public Water Supply datalayer
SR	DEP Sensitive Receptors datalayer
SW	DEP BWP Solid Waste Facilities datalayer

SWAP	Contracted data developed through DEP SWAP
TIGER	US Census Bureau TIGER Line Files
UST	DEP Underground Storage Tanks datalayer

Map Sources

Map source code indicates the type of map used.
MS_<Source> Standard Map source codes currently include:

LMTQ	Locus map based on USGS topographic quadrangle map
LMST	Locus map based on street information (ex. Street Atlas)
LMOT	Locus map other (ex. Trail map)
MCP	DEP MCP Site Scoring Map
PIM	DEP Pre-inspection Map
SITE	Detailed Site plan or map
SKCH	Hand sketched map
SURV	Survey grade map of site derived from traditional survey techniques
TAXM	Tax assessment map
USGS	USGS topographic quadrangle map
WWW	Internet map source (use L_COMM to record web URL)

Aerial Photography

Aerial Photography source code indicates the source or type of AP used.
AP_<Source> Standard aerial photography source codes currently include:

CIR	DWW Color Infrared photography 1:12,000
DOQ	MassGIS 1:5,000 digital orthophotography
GE	General Electric (GE) Project

Satellite Imagery

Satellite Imagery source code indicates the source of imagery used.
SI_<Source> Standard satellite imagery source codes currently include:

MSS	Multi-Spectral Scanner image
SPOT	SPOT Corporation image
TM	Thematic Mapper image
OT	Other

Other Sources

DS_GPS	DEP GPS field data sheet
KNOW	Located by DEP staff through knowledge gained in the course of their professional activities.
SV_<Date>	Site visited for the purpose of field verification and/or site inspection; Date should be recorded using the following format: 20010626 - June 26, 2001 20010600 - Year 2001, Month of June, day unknown 20010000 – Year 2001, month and day unknown 00000000 – Unknown year, month, day
TEXT	Location determined from textual description of site
	Location determined from verbal description

VERB	of site
OTHER	Other source (use L_COMM to record source type)

Unknown Source

NO_DATA	No data available; source unknown

MAINTENANCE

The DEP GIS Program, in cooperation with DEP Drinking Water Program (DWP) maintains this datalayer. Updates are made on a quarterly (Dec., Mar., June, and Sept.) basis, in accordance with the DWP's PWS new PWS source approval schedule. The updated datalayer is then shared through MassGIS.

As a standard component of this quarterly update, The DEP GIS Program removes abandoned sources in accordance with WQTS. The addition of new PWS sources is dependant on locational information made available by the DEP DWP at the time of quarterly update. Datalayer updates may also include refinements to existing PWS source locations.

If you have questions regarding this datalayer, please contact the DEP GIS Program at (617) 556-1115 or (617) 574-6856. General and technical questions regarding public water supplies or Massachusetts drinking water regulations should be directed to the DEP DWP (617) 556-1055.

In September, 2002, a new TYPE code ESW (Emergency Surface Water) was assigned to 65 surface water intake records to differentiate them from active and inactive surface water (SW) intakes. According to DEP Drinking Water Program policy ESWs (although still considered public water supplies under 310 CMR 22.00) do not have surface water supply protection areas.

In November, 2002, 6 sources were removed, 12 sources added, and 22 sources moved/refined. In March 2003 13 sources were added, 6 removed, and 60 locations refined. In April 2003 8 sources were added, 5 removed, and 38 modified.

In August, 2003, 41 sources were added, 13 sources were removed, and 35 source locations were revised.

In November, 2003, 15 source locations were added, 7 abandoned sources were removed, and 35 source locations were refined.

~ MassGIS ~

Datalayers/GIS Database

Aquifers - June 2003

Download this layer

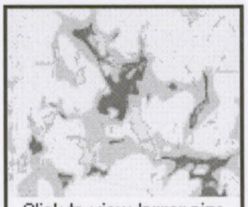
OVERVIEW

MassGIS produced an aquifer datalayer composed of 20 individual panels, generally based on the boundaries of the major drainage basins. Areas of high and medium yield were mapped. These panels, which were retiled for Librarian in the BASIN library, are called **AQ**. The layer is named **AQUIFERS**. The SDE layer is named **AQUIFERS_POLY**.

Aquifer polygons were not delineated for Cape Cod and the Elizabeth Islands. These areas in their entirety are considered by the Massachusetts Contingency Plan (MCP) as medium yield aquifers. The areas of Martha's Vineyard and Nantucket not delineated as high yield aquifers are also considered as medium yield under the MCP.

This datalayer **NO LONGER** includes polygon attribute coding to help in the identification of areas in which clean up of hazardous waste sites must meet drinking water standards, as defined in the Massachusetts Contingency Plan (MCP) (310 CMR 40.0000). Please refer to the DEP NPDWSA Datalayer for areas that are defined as Non Potential Drinking Water Source Areas.

MANUSCRIPT



Click to view larger size

The USGS 1:48,000 hydrologic atlas series on groundwater favorability was produced for all of Massachusetts. The basemaps for these were photographically reduced and spliced together from 1:24,000 USGS quadrangles. Each manuscript covers one of the major drainage basins. They have been individually researched and published by the USGS-WRD starting in the 1960s and continuing to the present. Several have been compiled but not yet published. In these cases the draft manuscripts were automated.

The definition of high and medium yield varies between panels, as it does on the source manuscripts. While the medium yield for most basins is between 100 and 300 gpm (gallons per minute), this range may vary greatly from basin to basin. High yield definitions vary from basin to basin as well. Yield for each panel is found in the metadata file AQ.SRC.

Entering the data in Librarian format modified the tiling scheme of this layer. The aquifers are now tiled by major basin grouping as illustrated in the Basin Index. However, the original tiling scheme may be recovered by reselecting on the PANEL item in the .PAT.

PRODUCTION

The high and medium yield categories were automated from the manuscripts. The major drainage basin boundary was copied from the MAJ_BAS coverage to use as a template for digitizing. Because ponds and lakes are also closely related to aquifers, they were clipped from water bodies in the 1: 100,000 Hydrography datalayer and also used as a template. The USGS manuscripts were not edgematched to adjacent panels; no attempt has been made to resolve interpretation inconsistencies between panels.

ATTRIBUTES

Both a polygon attribute table (**.PAT**) and an arc attribute table (**.AAT**) were created for each aquifer panel. The AAT has one item called OUTLINE. The drainage basin boundary is coded as '1'. All other arcs are coded as '0'.

Each **AQ.PAT** has the following items:

CODE	0 = Non-aquifer area 1 = Pond 2 = High yield (> 300 gallons per minute) 3 = Medium yield (100-300 gpm) 4 = Low yield (< 50 gpm)
TYPE	Character values the equivalent to the CODE item (POND, HIGH, MED, LOW)
YIELD_GPM	Yield in gallons per minute for the aquifer classes
TRANS	Transmissivity in square feet per day
AREA-ACRES	Area in acres of each polygon
PANEL	Original basin panel, used to identify source of aquifer data

The item PANEL stores the panel code identifying data sources and changes of the data from its original tiling scheme. Using the identifier PANEL as the link between the data and metadata, table AQ.SRC contains the AQ.DOC records from the original, individual aquifer coverages. More than one record may exist per panel.

EDITING

Plots of each panel were made at a scale of 1:48,000 and compared to the source map. Corrections were made as needed.

DISPLAYING THE DATA

To properly portray the aquifers with full statewide coverage, users should refer to the image above. This image displays the Aquifers layer symbolized on CODE or TYPE. If the display of NPDWSA is desired, see the "Displaying the Data" section in Non-Potential Drinking Water Source Areas layer.

MAINTENANCE

This datalayer is maintained by MassGIS. In June 2003, the DEP GIS group modified all tiles to remove the NPDWSA designations.

~ MassGIS ~

Datalayers/GIS Database

Underground Storage Tank Locations - March 1997

Download this layer

OVERVIEW

The Underground Storage Tank Locations datalayer (UST) was compiled by the U.S. Environmental Protection Agency through a contract with Camp, Dresser and McKee Federal Systems, Inc. Tabular information on tank sites was obtained from the Massachusetts Department of Public Safety's Division of Fire Protection Tanks database. Address information was extracted from the provided ASCII files and coordinates were acquired using a combination of address matching and field survey work using Global Positioning System receivers. Additional tabular information was extracted from this file by the MA Department of Environmental Protection (MA DEP). From this file of 10607 sites, 7995 were located by CDM. In 1996, the Barnstable County Department of Health and Environment (BCHED) field-visited sites in Barnstable County. The BCHED located 309 sites, of which 153 were new and 156 were previously located by address matching. PLEASE NOTE THAT FUNDING RESTRICTIONS PREVENTED ALL OF THESE SITES FROM BEING LOCATED AND INCLUDED IN THE DATALAYER. If you can provide the locations of missing sites, send a map manuscript showing the site and its USTID to MassGIS, Attn. Data Manager, 251 Causeway St., Suite 900, Boston, MA 02114.

METHODOLOGY

A report image file was provided to CDM from the MA Department of Public Safety (DPS) on diskette(s). The site address and USTID information were extracted from this file, and duplicate records were removed. During the early part of the collection effort fire chiefs from municipalities throughout Massachusetts were contacted and provided information for 276 new tank sites. The address matching software MATCHMAKER/GDT from Geographic Data Technologies Corp. was used to spatially locate the sites using address data from the U.S. Bureau of the Census TIGER/LINE files. Sites that were not located by this method were located using Global Positioning System survey equipment from Trimble Equipment Corp; these point locations were then provided to MA DEP GIS staff. Specific information concerning the tanks and contents at each location were then extracted from the DPS image file and loaded into a tabular database file. The content information was edited to minimize the types of products and a general category item was added. Information about total content at each site was also generated, and is a part of the coverage.

ATTRIBUTES

The datalayer has a .pat (point attribute file) associated with each location:

USTID	**The DPS Site Identification Number**
METHOD	**The method by which the point was mapped: ADDRESS, address matched; GPS or GPS-EPA located by GPS; GPS-BCHED located by BCHED**
FACIL-NAME	**The name of the facility**
STREET-NUM	**The street number portion of the address**
STREET	**The street name or intersection**
TOWN	**The municipality in which the UST is located**
STATE	**The state in which the UST is located**
ZIP	**The Postal Service Zip Code**
QC	**The QC field was created to place flags that may be of use to futureresearchers. The codes include:**

DUPLICATE1	**For two or more records in the original data file, the site name is the same or nearly the same, and the address is the same**
DUPLICATE2	**For two or more records in the original data file, the site name is different but the address is the same**
REMOVED	**The municipality responded that the tanks have been removed**
REMOVING	**The municipality responded that the tanks are being removed**
FILLED	**The municipality responded that the tanks have been filled**
ADDED	**The record was added by the municipality**
INACTIVE	**The municipality reported that the tanks are no longer in use**
NO RECORD	**The municipality reported no record of a UST at this site**

Several data files were created from the DPS site information file. These files are all related to the coverage .pat file by the USTID field:

UST.SITE-LIST, a list of site specific information. Attributes include:

USTID	**The DPS UST identification number**
COUNTY	**The Massachusetts county the site is located in**
NAME	**The owner or operator's name**
ADDRESS	**The street address**
CITY	**The city or town the site is located in**
ZIP	**The Postal Service Zip Code**
MANAGER	**The site manager**
PHONE	**The phone number at the site**

UST.ACTIVE, or UST.REMOVED, lists of active and removed tank information by site. Attributes include:

USTID	**The DPS UST identification number**
TANKID	**Tank number by site**
STATUS	**The status of the tank, i.e. "Curr, temp, Perm, Remv"**
PRODUCT	**The contents of the tank, i.e. "#2 Diesel Fuel, Toluene"**
CATEGORY	**A more general product description, added to aid summary by sites. Only exists in UST.ACTIVE. Current codes includedare:**

CHEMICAL, DIESEL, FUEL OIL, GAS(eous), GASOLINE, GLYCOL, HAZARDOUS, KEROSENE, LUBRICANT, MIXTURE, NONE, SOLID,

UNKNOWN, WATER

CAPACITY	**Tank capacity in gallons**
AGE	**Tank age in years, updated to 9/94**
YEAR-INSTALLED	**Year the tank was installed**
MATERIAL	**Tank construction material, i.e. "Fiberglass"**
PIPING-MAT	**Connecting pipe construction material, i.e. "Bare Steel"**
PIPING-TYPE	**Connecting pipe type. i.e. "Gravity Fed"**

Additional files were generated using a frequency filter for site specific totals of material stored to aid in map generation:

UST.SITE-PRODUCTS, a summary file for each site by type of product. Attributes include:

CASE#	**A sequential record number**
FREQUENCY	**Count of each product type**
USTID	**The DPS UST identification number**
PRODUCTS	**Tank contents**
GALLONS	**Total gallons at site by product**

UST.SITE-CATEGORY, a summary file for each site by content category. Attributes include:

CASE#	**A sequential record number**
FREQUENCY	**Count of each product type**
USTID	**The DPS UST identification number**
CATEGORY	**Tank contents category**
GALLONS	**Total gallons at site by product**

The original table from the Barnstable County Department of Health & Environment is attached to the coverage as UST.BCHED, please contact the Department for information pertaining to the fields.

MAINTENANCE

The MA Department of Environmental Protection, GIS Group, is maintaining this datalayer. Any updates sent to MassGIS will be forwarded to DEP and incorporated into this datalayer. Please reference the USTID when informing us of new or corrected data.

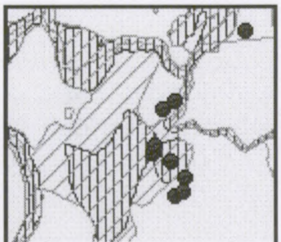
~ MassGIS ~

Datalayers/GIS Database

NHESP Certified Vernal Pools - July 2003

Download this layer

OVERVIEW



Click to view larger size

This datalayer contains points for all vernal pools that have been certified by the Natural Heritage & Endangered Species Program (NHESP) according to the Guidelines for Certification of Vernal Pool Habitat (5/88, MA Division of Fisheries & Wildlife). The 2003 version of the datalayer shows all pools that were certified as of December 2002.

Vernal pools are small, shallow ponds characterized by lack of fish and by periods of dryness. Vernal pool habitat is extremely important to a variety of wildlife species including some amphibians that breed exclusively in vernal pools, and other organisms such as fairy shrimp, which spend their entire life cycles confined to vernal pool habitat. Many additional wildlife species utilize vernal pools for breeding, feeding and other important functions. Certified vernal pools are protected if they fall under the jurisdiction of the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00). Certified vernal pools are also afforded protection under the state Water Quality Certification regulations (401 Program), the state Title 5 regulations, and the Forest Cutting Practices Act regulations. However, the certification of a pool only establishes that it functions biologically as a vernal pool. Certification does not determine that the pool is within a resource area protected by the Wetlands Protection Act.

The Certified Vernal Pools layer is stored as a single coverage named **CVP2003**. Within EOEA this layer is found in the $EOEAONLY library and as the ArcSDE layer **CVP2003_PT**.

PRODUCTION

The certified vernal pool data are mapped on 1:24,000 or 1:25,000 USGS topographic quadrangle maps. The datalayer was created by NHESP by generating an Arc/Info coverage from a database of latitude and longitude points read from the USGS quads.

ATTRIBUTES

This datalayer has an attribute called 'CVP_NUM' that contains a unique numeric identifier. This number may be used to identify a Certified Vernal Pool when contacting the Natural Heritage Program.

DISPLAYING THE DATA

The legend that MUST accompany this datalayer on ALL maps is:

"NHESP 2003 Massachusetts Certified Vernal Pools"

MAINTENANCE

Occurrence records from the NHESP database are continuously being added, modified and deleted. Those changes are incorporated into the Certified Vernal Pools datalayer every two years for inclusion in the Natural Heritage Atlas. Questions about this datalayer should be directed to NHESP at 508-792-7270 x161.

Also see these layers:

- NHESP Priority Habitats of Rare Species
- NHESP Estimated Habitats of Rare Wildlife
- NHESP Potential Vernal Pools

DEP Solid Waste Facilities - June 2002

Download this layer: Arc Export File (.e00) | ESRI Shapefile

OVERVIEW

The Solid Waste Facility Datalayer was compiled by the Department of Environmental Protection (DEP) to track the locations of landfills, transfer stations, and combustion facilities. This statewide datalayer contains the majority of facilities currently regulated under DEP's solid waste regulations (310 CMR 16.00 & 19.00). The 678 polygons in the datalayer include thirteen specific types of solid waste facilities (see ATTRIBUTES below) and are stored as a statewide polygon coverage, **SW**.

Please note although the majority of the polygons represent landfills, only a small fraction of those landfills are active. Furthermore, this datalayer contains only solid waste facilities for which DEP had sufficient mapping information to provide a location. The MassGIS Land Use datalayer has waste site and mining classifications that may represent landfills not in the solid waste datalayer.

MANUSCRIPT

The solid waste datalayer was originally digitized from USGS Quadrangle maps (1:25,000) filed as part of the operating permit (310 CMR 19.00) or siting (310 CMR 16.00) requirements for landfills. It has been updated as described below.

METHODOLOGY

1994 and earlier: DEP regional office files were searched for locus maps and site plans which designated the location of solid waste facilities. In some cases the footprint of the facility was located on the map, in other instances a general location was marked on the map. These were hand-drawn onto a master set of USGS topographic quadrangle maps from which the datalayer was digitized. When possible, point locations were updated with polygons from MassGIS 1985 land use data. Point locations were buffered to reflect the reported acreage (when insufficient data was available, 29.7 acres was used).

1997 and beyond: Locus maps and site plans from regional and Boston office files were automated directly into ARC/INFO while using scanned USGS quads &/or digital orthophotos as background images. Point locations were buffered as described above; several of these point locations were collected using global positioning systems technology (GPS). One polygon was copied from the Protected and Recreational Open Space Datalayer.

The Department of Environmental Protection will continue its program of field checking existing facilities using GPS. 1:5,000 digital orthophoto basemaps are being used for site verification. DEP plans to use GPS during site inspections to further enhance the quality of the datalayer.

ATTRIBUTES

The datalayer has a polygon attribute table (**SW.PAT**, **swp1.dbf** in the shapefile download), which includes the following feature attributes:

Feature attributes (.PAT):

ACRES	10 / N	Facility Area in Acres
REG	6 / C	DEP Administrative Region
LNK	10 / C	Unique identifier and link to related table SW.DAT

The LNK field contains an identifer, for linking related tables. The SW polygon relate table (SW.PRL) contains the supported Arc/INFO relate environment for the SW datalayer (for use in Arc/INFO Workstation software).

The related "location documentation table" (**SW.LDT**, **swld.dbf** in the shapefile download) contains standard DEP data documentation fields. Please see the layer's polygon attribute codes metadata table (SW.PAC) for a complete description of documentation codes.

Location Documentation Fields (SW.LDT):

LNK	C / 10	Unique Identifier
L_BASE	C / 3	Base map type code
DIG_METHOD	C / 3	Data Input Method
L_ACC_EST	I / 4	Location accuracy estimate measurement in ft. (0 = Unknown)
L_TYPE	C / 4	Location type code
L_METH	C / 4	Location method code
L_SRC_1	C / 30	Primary source material code
L_SRC_2	C / 30	Secondary source material code
L_SRC_3	C / 30	Tertiary source material code
L_DATE	C / 8	Date of automation

The DIG_METHOD field contains a code indicating the digitizing method or source of the polygon (see metadata table **SW.DIG-FREQ**, **swdi.dbf** in the shapefile download):

DIG-METHOD	Description	Number of Polygons
F	Footprint digitized from USGS quadrangle	441
P	Point digitized from USGS quadrangle	150
UTM	Point located by UTM coordinates	71
GPS	Perimeter or front gate points collected with GPS	10
LU	Polygon copied from MassGIS Land Use Datalayer	5
OS	Polygon copied from MassGIS Protected and Recreational Open Space Datalayer	1

RELATED DATABASE TABLE

A related solid waste data table **SW.DAT** (**swdt.dbf** in the shapefile download) contains information about the one or many solid waste facilities that may be associated with a given polygon. Facility IDs are assigned according to Facility Type (two-character abbreviation), Town (digits preceeding decimal), and a unique identifier (digits following decimal). The relate item LNK is a concatenation of the town-id and a character representing the unique identifier (001 = A, 002 = B, etc).

Solid Waste Data Fields (SW.DAT):

LNK	Link to SW.PAT
ID	Unique Identification Number assigned to each solid waste facility
IDNUM	ID item without the two-character Facility Type abbreviation
TYPE	1 = Landfill, 2 = Combustion Facility, 0 = Other (CO, EP, IL, RE, TI, TR).
FAC_TYPE	Facility type. See description of codes below.
SITE_NAME	Facility name found in Solid Waste Database
ADDRESS	Facility address
TOWN	Municipality
REGION	DEP Administrative Region (C =Central, N = Northeast, S = Southeast, W = Western)
ACRES_BOH	Number of acres site assigned by local Board of Health
ACRES_DEQE	Number of acres approved by DEP for solid waste handling or fill, or an actual landfill footprint
ASSIGNDATE	Date of site assignment by, local Board of Health
CAP_TEXT	Textual description of landfill cap (listed above)
CAPYEAR	Year cap construction or excavation completed
CAPCERTDAT	Date DEP certified the closure or excavation of a landfill
CLOSEBASE	Year facility ceased operations
LEACHCOLLECT	Method of leachate collection (sewer, holding tank, lagoon)
LINER	Landfill liner code. Null for non-landfill records Y = some or all of the landfill is lined N = no part of the landfill is lined
LINER_TEXT	Landfill liner status (lined/unlined as defined above)
OPERATOR	Name of facility operator
OPENBASE	Year facility began handling solid waste
OPER_TYPE	Operator Type (Federal, Municipal, Private, State, Unknown)
OWNER_TYPE	Owner Type (Federal, Municipal, Private, State, Unknown)
OWNER	Name of owner
RTN	Release Tracking Number
STATUS	Facility Status: A = Active: Presently operating I = Inactive: Not operating, not properly closed C = Closed: Not operating; unlikely to operate in the future
TONS_DAY	Tons per day of solid waste a facility may handle or dispose according to permit or actual operations data
LOCNOTE	Information about the location (ex. transfer station located at landfill)
GENNOTE	General information about the facility/site
MAPTXT	Label item: Facility ID - <status>

Types of Facilities (from FAC_TYPE item, as listed in metadata table **SW.TYPE-FREQ**, **swty.dbf** in the shapefile download):

AL	Ash landfill; takes or has taken only ash.
CO	Compost site; a registered yard waste composting site.
DL	Demolition landfill; takes or has taken only construction & demolition (C&D) waste and may take wood waste.
EP	Epic (Unconfirmed) Site; identified by aerial photos taken approximately 1972-74 by Water Supply as possible solid waste sites, or a site with minimum data to support its existence. When a site is verified, its type is changed to a more specific site type.
IL	Illegal; solid waste facility that requires site assignment by the local Board of Health but has not obtained it and continues to operate. Most commonly refers to illegal transfer station operations.
MI	Municipal incinerator; burns MSW (Municipal Solid Waste) without energy recovery.
RE	Recycling facility; materials recovery facility or other recycling operation that does not require site assignment. RE does not include Recycling Drop-off Centers.
RR	Resource Recovery Facility; burns MSW with mass burn or refuse derived fuel technology with energy recovery.
SL	MSW landfill; may take or have taken MSW, in addition may take or have taken wood waste, C&D, sludge, ash or other solid waste. SL includes historic open or burning dumps used to dispose of MSW.
SG	Sludge landfill; takes or has taken sludge from water supply or waste water treatment only. These landfills are primarily tracked and regulated by DEP Division of Water Pollution Control.
SD	Stump landfill or wood reclamation facility; takes or has taken only clean wood waste.
TI	Tire pile
TR	Transfer station; any facility that handles, but does not dispose of solid waste and requires site assignment.

e.g.

`LNK=004ABD DEQE-ID=SL0004.001 TYPE=1`

- A sanitary landfill in Adams (TOWN-ID 4), the first registered facility in the town.

`LNK=004ABD DEQE-ID =TR0004.002 TYPE=0`

- A transfer station in Adams (TOWN-ID 4), the second registered facility in the

town.
LNK=004C DEQE-ID=SG0004.003 TYPE=1
 - A sludge landfill in Adams (TOWN-ID 4), the third registered facility in the town.
LNK=004ABD DEQE-ID=CO0004.004 TYPE=0
 - A compost site in Adams (TOWN-ID 4), the fourth registered facility in the town

Note: SL0004.001, TR0004.002 and CO0004.004 are represented by the same polygon (LNK = 004ABD). SL0004.001 and SG0004.003 are both landfills (TYPE = 1), located at different polygons (LNK = 004ABD and 004C).

DEP maintains the Solid Waste Facility Database which tracks the liner and operational status, facility type, capacity, owner and operator contact information, and years of operation of solid waste facilities. A subset of this database is found within the SW datalayer (SW.DAT). Facility information is linked to the GIS datalayer via the Facility ID number. The Facilities database is available through DEP's Bulletin Board: (617) 292?5546; 14400 Baud, 8 data, 1 stop, no parity; or the World Wide Web: http://www.mass.gov/dep/bwp/dswm/dswmpubs.htm.

(Please note that with the June 2002 update the related table SW.IDS has been removed).

MAINTENANCE

The DEP Bureau of Waste Prevention maintains this datalayer.

~ MassGIS ~

Datalayers/GIS Database

Orthophoto Wetlands and Streams (1:5,000) - *November 2003*

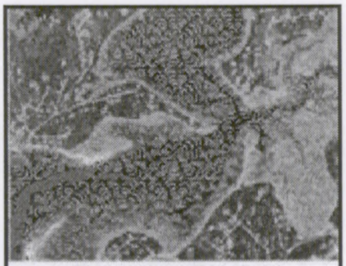
Download these layers: Wetland polygons | Stream arcs

OVERVIEW

The Orthophoto Wetlands and Streams datalayers comprise a polygon coverage and a line coverage. They are registered to, and tiled by, the Orthophoto Quad Library. The attribute codes in the WETLANDS polygon coverage describe different types of wetland environments. The Wetlands polygon coverages are named W and compose the WETLANDS layer. The arcs in the line coverages, which are named S, represent streams and compose the STREAMS layer.

New - View these Wetlands online

METHODOLOGY



Click to view larger size

The wetlands were interpreted from stereo, 1:12000 scale, color-infrared photography by staff at UMASS Amherst. The interpretation is field checked by Department of Environmental Protection (DEP) Wetlands Conservancy Program (WCP). Completed interpretations are then scanned at 250 dpi with a Howtek Scanmaster 3+. The resulting images are converted to ARC/INFO coverages using ARCSCAN with additional processing in ARCEDIT. The distortion from terrain and camera coordinates are removed using a combination of PHOTOGIS, a photogrammetry software program, and a digital terrain model (DTM) derived from 1:5,000 black and white ortho-rectified digital aerial photography. In ARC, the corrected coverages are then mapjoined and clipped by the boundary of a State Plane Coordinate grid cell which represents a 4 kilometer by 4 kilometer orthophoto sheet. Plots are generated at 1:5,000 scale and final quality control is performed at that scale. It should be noted that the resulting wetlands are for planning purposes only; final wetland boundary determination must accord with MA Act M.G.L. c. 131.

ATTRIBUTES

Currently all attribute information for the wetlands coverages is maintained in ARC/INFO in a PAT. The WETCODEs are incorporated as annotext (ARC/INFO feature class annotation, subclass WET) in the datalayer.

The wetland coverage **W.PAT** is populated with these items:

ITEM NAME	WDTH	OPUT	TYPE	N.DEC	DESCRIPTION
WETCODE	4	5	B	-	WETLAND CONSERVANCY CODES
ITEM_VALUE_C	12	12	C	-	WETLAND LABEL ABBREVIATIONS
ITEM_VALUE_DESC	60	60	C	-	DESCRIPTION OF WETLAND LABELS

The following types of wetlands are represented in the datalayer:

WETCODE	ITEM_VALUE_C	ITEM_VALUE_DESC
1	BA	COASTAL BANK BLUFFOR SEA CLIFF
2	BB	BARRIER BEACH SYSTEM
3	BE	COASTAL BEACH
4	BG	BOG
5	CB	CRANBERRY BOG
6	D	COASTAL DUNE
7	DM	DEEP MARSH
8	M	SHALLOW MARSH MEADOWOR FEN
9	OW	OPEN WATER
10	RS	ROCKY INTERTIDAL SHORE
11	SM	SALT MARSH
12	SS	SHRUB SWAMP
13	TF	TIDAL FLAT
14	WS1	WOODED SWAMP DECIDUOUS
15	WS2	WOODED SWAMP CONIFEROUS
16	WS3	WOODED SWAMP MIXEDTREES
17	BB-BE	BARRIER BEACH-COASTALBEACH
18	BB-BG	BARRIER BEACH-BOG
19	BB-D	BARRIER BEACH-COASTALDUNE
20	BB-DM	BARRIER BEACH-DEEPMARSH
21	BB-M	BARRIER BEACH-MARSH
22	B-OW	BARRIER BEACH-OPENWATER
23	BB-SS	BARRIER BEACH-SHRUBSWAMP
24	BB-WS1	BARRIER BEACH-WOODEDSWAMP DECIDUOUS
25	BB-WS2	BARRIER BEACH-WOODEDSWAMP CONIFEROUS
26	BB-WS3	BARRIER BEACH-WOODEDSWAMP MIXED TREES
27	BB-SM	BARRIER BEACH-SALTMARSH
88	N/A	N/A
99	U	UPLAND

An AAT exists in the Wetlands polygon coverage. The only lines coded represent the edge of a N/A, or not-interpreted area. Item W<sheet-id>-id for these arcs is coded 9999.

The **S.AAT** for each stream coverage possesses arcs with S<sheet-id>-id coded 8888 and no other attributes. All arcs represent streams.

MAINTENANCE

These datalayers are being developed by DEP GIS group. Distribution is through MassGIS. Questions may be directed to DEP GIS to 617-574-6890.

The datalayers are currently under development. Please consult the current project Status Map for the most up-to-date availability. The dates when the Wetlands and Streams were added to the OQ library are stored in the DATEWET and DATESTRM items in the statewide Orthophoto Index layer.

~ MassGIS ~

Datalayers/GIS Database

1:5,000 Color Ortho Imagery - *December 2002*

Download these images

OVERVIEW

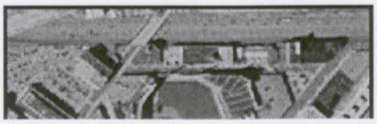
These medium resolution true color images are considered the new "basemap" for the Commonwealth by MassGIS and the Executive Office of Environmental Affairs (EOEA). MassGIS/EOEA and the Massachusetts Highway Department jointly funded the project. The photography was captured in April 2001 when deciduous trees were mostly bare and the ground was generally free of snow. Imagery is available for all of the state except the Elizabeth Islands, Marthas Vineyard, and Nantucket. For these areas black and white ortho imagery is available.

View the images (1/2-meter MrSID Mosaics) with the MassGIS Color Ortho Imagery Viewer

PRODUCTION

Keystone Aerial Surveys Inc. (KAS) of Philadelphia, PA acquired the aerial photography for the entire project using Kodak AeroColor 2444 and AeroColor 2445 film. KAS used large format Leica RC-30 calibrated aerial mapping cameras employing forward motion compensation and gyro-stabilized mounts. Each camera was also equipped with a tie to the aircraft GPS receiver. The flying altitude was approximately 15,000 feet to provide an original photo scale of 1" = 2,500'. Endlap (forward overlap) was 60%, except 80% in areas with tall structures, with (high) sidelap of 42%.

The processing of the photos was conducted by two firms. Intermap Technologies of Englewood, Colorado and Ottawa and Calgary, Canada processed the mainland portion of the Commonwealth east of the 165000-meter line (in MA State Plane coordinates) and Chas. H. Sells, Inc. of Charlton, MA processed the remaining area west of this line (approximately 72 degrees longitude). These vendors provided scanning, softcopy aerial triangulation, orthorectification, image mosaicking and quality control.



Ground and photogrammetric control (elevation model) for the orthorectification of the aerial photography was available statewide from the previous black-and-white

1:30,000 digital orthophotography program conducted from 1992-2000 (see the Black and White Orthophoto datalayer description). The transfer of control from that project made the creation of these new data much more efficient, and assured a very high level of accuracy and compatibility.

The color negatives were scanned at 14 (12.5 Sells) microns and then inverted. The pixels were subsequently resampled to 0.5 meters ground resolution. Each pixel is coded with three 8-bit values representing the amounts of Red, Green, and Blue in the pixel. This produces a 24-bit RGB image. 8-bit (values ranging 0-255) Red, Green, and Blue values are packed into a single 24-bit identity. This allows for a maximum of 16,777,216 unique combinations of colors.

The imagery was radiometrically balanced prior to mosaicking. Only minor adjustments were made to the brightness and contrast. In the Intermap data, to avoid color distortion of land areas, color balancing was preceded by the removal of data in large bodies of water and the ocean. The water pixels were then merged back in. Since the Sells data did not contain large bodies of water (except for the Quabbin Reservoir), it was not processed in this manner.

The original 0.5 meter data was delivered to MassGIS in GeoTIFF format in orthoquad tiles representing 4 x 4 km on the ground (8000 rows x 8000 columns, equaling 64,000,000 pixels). Since each pixel contains 24 bits (3 bytes) of data, a full resolution image covering one orthoquad tile is approximately 192,000,000 bytes (183 Megabytes) in size. The tiles are based on the Orthophoto Index Grid and are named <sheet-id>.tif, where the <sheet-id> is the first 3 digits of the state plane XY coordinate pair for the lower right corner of each cell. Header files (named <sheet-id>.tfw) were also delivered for use in some GIS software. Imagery is georeferenced to Massachusetts State Plane (Lambert Conformal Conic Projection) NAD83 denominated in meters.

BSC Group fulfilled land survey requirements by performing highly precise ground control survey & independent verification and validation of spatial accuracy.

DISTRIBUTION

Due to the large size of the original half-meter GeoTIFF images, MassGIS is making available these images in MrSID format, as follows:

- as **large regional mosaics**. These MrSID mosaics (from half-meter tiffs compressed at a 30:1 ratio) may be **ordered** on CD-ROM based on the Half-Meter Mosaic CD Scheme (see the mosaic scheme's Datalayer Description and Index Map pages).
- as **4 x 4 km tiles** (based on the Ortho Index tiling scheme). These may be **downloaded**. Includes MrSID files produced from half-meter and one-meter tiffs compressed at a 20:1 ratio.

View the images with the MassGIS Color Ortho Imagery Viewer

DISPLAYING THE IMAGES

Color Tone

Users should note that color tone and balance are always based on personal preference. Image color processing frequently involves a series of compromises with the overall objective of providing images "with the appearance that people expect". Different hardware (monitor, video card, etc.), software, and subjective perceptual differences can all contribute to the perception of color in these images. Users should also note that visual differences may be apparent between the eastern and western images due to slightly different processing methods by the two vendors.

Printing

Printing or plotting the images further introduces variability due to different hardware and software systems, etc. Therefore MassGIS is distributing the imagery as processed by our vendors and leaving additional enhancement (e.g., contrast and brightness adjustment, etc.) to the user. For example, ArcGIS 8.x users may want to set the display properties for these images to "Resample during display using Cubic Convolution (for continuous data)" in the Properties box, Display tab. (The Cubic display method may result in gaps between adjacent images; ESRI is working to fix this). Other options include adjusting the Contrast and Brightness settings on the Effects Toolbar or applying a stretch (e.g. Standard Deviation) to the images in the Properties box, Symbology tab. Achieving results you like may take exploring the capabilities of your software and hardware, which can take considerable time.

Displaying with Feet-based data

Users may successfully display our meters-based imagery in ArcView 3.x with other data in NAD83 Mass. State Plane feet simply by changing the accompanying .sdw files and installing the newest version of the file AVMrSID.dll.

The process is as follows:

1 - Open the .sdw file in a text editor and multiply all values by 3.2808333316 and save

2 - Place the AVMrSID.dll file in the BIN32 folder where ArcView is installed (e.g., C:\ESRI\AV_GIS30\ARCVIEW\BIN32)

If users wish to display the images with feet-based (or any) data in ArcMap, load the image file (.sid) and the companion .aux file and the data (if it has a .prj file, indicating a defined spatial reference for vector data) and the images will project on the fly (ArcMap does not use the .sdw).

Black areas in ArcView 3.x

Users may experience black areas adjacent to the mosaics in ArcView GIS 3.x. In such cases, make the image themes active, choose Theme > Properties, and select 'display' from the 'Extent Limit' dropdown.

MAINTENANCE

The datalayer is maintained by MassGIS. Additional information concerning the technical details of the project may be available upon request.

Please note that MassGIS does not have any old aerial photographs (pre-1992). For information on such products please see http://erg.usgs.gov/isb/pubs/factsheets/fs12796.html.

APPENDIX H

RIGIS Datalayer Metadata

Community Wells Metadata

RIGIS-CAT-ID =s44hwc97
DATA-SET-IDENT =cwells
DISTRIB-NOTES =(c)rigis 1989 licensed rigis data
THEME-KEYWORDS =public water supply community wells groundwater
DESCRIPTION1 =wells that serve as a public water supply with at
DESCRIPTION2 =least 15 service connections used by year round
DESCRIPTION3 =residents or that regularly serve 25 residents
ACC-REV-DATE =0100
DATA-STRUCTURE =vector with feature attributes
COORD-PRECIS =arc-info single precision
INTENDED-USE =statewide geographically referenced inventory
INTENDED-SCALE =24000
TRANSFER-FORMAT =arcinfo export
TRANSFER-SIZE =0.16 mb
SPLOBJ-TYPE =point
RESOLUTION =na
SPLOBJ-COUNT =159
AREA-EXT-BND =ll-234582 27254 ur-425966 337616
AREA-EXCL-BND =only wells classified as community wells by ridoh
PROJECTION =transverse mercator
COORDSYS-UNIT =rispc-feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd29
REL-DB-ID =cwells.pat
REL-DB-ORG =ridem-ridoh
FIELD-NAME1 =wellname
FIELD-CHAR1 =60 c
FIELD-DESC1 =name of facility or well as listed by ridoh-ridem
FIELD-DOM1 =text
FIELD-ASSC1 =ridem water rescources databases
FIELD-NAME2 =demid
FIELD-CHAR2 =7 i
FIELD-DESC2 =ridem facility or well identification number
FIELD-DOM2 =7 figure numeric code
FIELD-ASSC2 =ridem water resources databases
FIELD-NAME3 =source
FIELD-CHAR3 =8 c
FIELD-DESC3 =method used for obtaining well coordinate location
FIELD-DOM3 =ag-gps demw dem-gps usgs-ll
FIELD-ASSC3 =cwells.ref
FIELD-NAME4 =material
FIELD-CHAR4 =6 c

FIELD-DESC4 =geologic material in which well is located
FIELD-DOM4 =b-bedrock sd-stratified drift
FIELD-ASSC4 =ridem water resources and rigis databases
FIELD-NAME5 =pumprate
FIELD-CHAR5 =6 c
FIELD-DESC5 =well pumping rate in gallons per minute
FIELD-DOM5 =10-1578
FIELD-ASSC5 =ridem water resources and ridoh databases
FIELD-NAME6 =townname
FIELD-CHAR6 =17 c
FIELD-DESC6 =town in which well is located
FIELD-DOM6 =text
FIELD-ASSC6 =na
SOURCE-CRTR =ridoh-ridem
SOURCE-ORIG1 =ridoh database of public wells
SOURCE-ORIG2 =ridem and usgs lat-long files and ridem gps data
BIBLIOG-REF =ridem community wells document procedures files
SOURCE-SCAL =24000-usgs 7.5 minute quad maps
SOURCE-DATE =ridoh-1196 ridem gps in 1996-1997
DATA-DATE =ridoh-1196 ridem gps in 1996-1997
AUTO-EQPT =workstation arcinfo trimble pathfinder gps
AUTO-PROC1 =132 coordinate locations of and wells from
AUTO-PROC2 =ridoh list were repositioned with gps in field
AUTO-PROC3 =remaining 27 coordinate logcations from s44hwc96
PROC-TOL =location tolerences varied-not to rigis standards
PROC-DATE =gps-1997
POS-ACCU =plus or minus 50 feet-worst case scaled from quads
POS-ACCUCK =visual inspection of overlay maps
ATTR-ACCU =rigis standards 99 perecent
ATTR-ACCUCK =visual inspection of attribute tables
DATA-INTEG =complete arcinfo point coverage
METADATA-LIST =0599-cpb and 0400-jds
CONTACT-TITLE =gis manager ridem
CONTACT-ORG =ri department of environmental management-planning
CONTACT-ADDR =235 promenade street
CONTACT-CTYST =providence ri 02903
CONTACT-PHONE =401-222-2776-x4315
CONTACT-EMAIL =pjordan-at-dem.state.ri.us

CWELLS.REF - Attribute Coding Descriptions
for s44hwc97 - cwells
RIDEM Community Wells for Public Water Supply Systems

SOURCE - Methods used for obtaining well coodinate locations

AG-LL - Uncorrected GPS Lat/Long value form RIDEM Agricultural Division

DEM(W) - RIDEM scaled Lat/Long position of facility on USGS 7.5 minute quad maps

DEM-GPS - RIDEM differentionally corrected GPS Lat/Long values

USGS-L - Lat/Long Coordinates from USGS file

Glacial Geology Metadata

RIGIS-CAT-ID =s44ggl88
DATA-SET-IDENT =GLACGEOL
DISTRIB-NOTES =(c)rigis 1989
THEME-KEYWORDS =glacial deposits surficial geology outwash till
DESCRIPTION1 =surficial geology showing glacial deposits and
DESCRIPTION2 =features including outwash and till deposits
DESCRIPTION3 =and some but not all bedrock outcrops
ACC-REV-DATE =1289
DATA-STRUCTURE =vector topological with feature attributes
COORD-PRECIS =arc-info single precision
INTENDED-USE =groundwater resource inventory and management
INTENDED-SCALE =24000
TRANSFER-FORMAT =arc-info export
TRANSFER-SIZE =12-7 mb
SPLOBJ-TYPE =polygon
RESOLUTION =one quater acre
SPLOBJ-COUNT =5220
AREA-EXT-BND =LL 225189.969 22904.504 UR 432051.281 340916.906
AREA-EXCL-BND =inconsistant for inclusion of bedrock outcrop
PROJECTION =transverse mercator
COORDSYS-UNIT =RISPC-feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd29
REL-DB-ID =GLACGEOL.PAT
REL-DB-ORG =ridem groundwater
FIELD-NAME1 =glacial-id
FIELD-CHAR1 =4 5 n
FIELD-DESC1 =polygon identifier
FIELD-DOM1 =0-5220
FIELD-ASSC1 =na
FIELD-NAME2 =deposit
FIELD-CHAR2 =2 2 i
FIELD-DESC2 =outwash-till-mixed outwash till-water-bedrock
FIELD-DOM2 =text
FIELD-ASSC2 =na
FIELD-NAME3 =feature
FIELD-CHAR3 =10 10 c
FIELD-DESC3 =numeric coding for field name2-deposit
FIELD-DOM3 =1-5 inclusive
FIELD-ASSC3 =na
FIELD-NAME4 =
FIELD-CHAR4 =

FIELD-DESC4 =
FIELD-DOM4 =
FIELD-ASSC4 =
FIELD-NAME5 =
FIELD-CHAR5 =
FIELD-DESC5 =
FIELD-DOM5 =
FIELD-ASSC5 =
FIELD-NAME6 =
FIELD-CHAR6 =
FIELD-DESC6 =
FIELD-DOM6 =
FIELD-ASSC6 =
SOURCE-CRTR =usgs-ri water resources coord board
SOURCE-ORIG1 =groundwater quad maps by hahn and hansen-usgs
SOURCE-ORIG2 =
BIBLIOG-REF =none
SOURCE-SCAL =24000
SOURCE-DATE =1961
DATA-DATE =1961
AUTO-EQPT =prime main frame arc-info
AUTO-PROC1 =glacial outwash-till-mixed outwash till and water
AUTO-PROC2 =areas were manually digitized from source maps
AUTO-PROC3 =with digitizing tablets - some bedrock outcrops
PROC-TOL =rigis standards fuzzy-002 rms-005
PROC-DATE =1289
POS-ACCU =plus or minus forty feet
POS-ACCUCK =visual inspection of overlay proof plots
ATTR-ACCU =rigis standards 99 percent
ATTR-ACCUCK =visual inspection of coded proof plots
DATA-INTEG =topologically complete arc-info polygon coverage
METADATA-LIST =1098-js
CONTACT-TITLE =rigis coordinator
CONTACT-ORG =ri department of administration-planning
CONTACT-ADDR =one capitol hill
CONTACT-CTYST =providence ri 02908-5872
CONTACT-PHONE =401-222-6483
CONTACT-EMAIL =stach@rigis.doa.state.ri.us

Hydrolines Metadata

RIGIS-CAT-ID =s44hhl98
DATA-SET-IDENT =rigis-state-hydrol98
DISTRIB-NOTES =' ' (c)rigis-1989
THEME-KEYWORDS =river stream centerline water hydrography
DATASET-DESC1 =river and stream centerlines including
DATASET-DESC2 =intermittant streams depicted as linear
DATASET-DESC3 =features on usgs 7-5 minute quad maps
ACC-REV-DATE =1289 and 698
DATA-STRUCTURE =vector toplogical
COORD-PRECIS =arc-info single precision
INTENDED-USE =state wide water resource inventory and mapping
INTENDED-SCALE =24000
TRANSFER-FORMAT =arc-info export
TRANSFER-SIZE =4.1 mb
SPLOBJ-TYPE =line
RESOLUTION =all streams shown on 7-5 minute usgs quads
SPLOBJ-COUNT =4470 arcs 111546 segments
AREA-EXT-BND =LL 234010.094 31361.369 UR 430921.938 340865.844
AREA-EXCL-BND =lakes ponds and rivers wide enough to be polygons
PROJECTION =transverse mercator
COORDSYS-UNIT =RISPC-feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd29
REL-DB-ID =hydrol98.aat
REL-DB-ORG =RIDEM
ITM1-RIHYDROL-ID=
FIELD-CHAR1 =4 5 B 0
FIELD-DESC1 =arc identifying number
FIELD-DOM1 =0-4208
FIELD-ASSC1 =
ITM2-NA =NAME
FIELD-CHAR2 =50 50 c
FIELD-DESC2 =geographic names for rivers and streams
FIELD-DOM2 =text
FIELD-ASSC2 =GNIS
SOURCE-CRTR =usgs
SOURCE-ORIG1 =usgs mylar 7-5 minute quad maps
SOURCE-ORIG2 =USGS Geographic Names Inventory System-GNIS
BIBLIOG-REF =USGS Geog. Names Inventory System-GNIS
SOURCE-SCAL =24000
SOURCE-DATE =1976-1983

DATA-DATE =1988
AUTO-EQPT =prime mainframe arc-info
AUTO-PROC1 =linear hydrographic features were manually
AUTO-PROC2 =digitized from source maps with tablets
AUTO-PROC3 =usgs quad map names added as attributes
PROC-TOL =rigis standards rms-005 fuzzy-002
PROC-DATE =digitized lines in 1988-name attributes in 1998
POS-ACCU =plus or minus 50 feet
POS-ACCUCK =inspection of overlay proofs with source
ATTR-ACCU =rigis standards 99 percent
ATTR-ACCUCK =manual inspection of name attributes
DATA-INTEG =topologically complete arc-info line coverage
METADATA-LIST =1098-js
CONTACT-TITLE =GIS Specialist RIDEM
CONTACT-ORG =RI Dept of Environ Mngt-Planning-GIS
CONTACT-ADDR =235 Promenade Street
CONTACT-CTYST =Providence RI 02908
CONTACT-PHONE =401-222-6483
CONTACT-EMAIL =stach@rigis.doa.state.ri.us

Major Surface Water Bodies Metadata

RIGIS-CAT-ID =s44hhm99
DATA-SET-IDENT =lakes
DISTRIB-NOTES =(c)rigis 1989 licensed rigis data
THEME-KEYWORDS =rivers lakes ponds surface fresh water quality
DESCRIPTION1 =major surface fresh water rivers lakes and ponds
DESCRIPTION2 =in rhode island with name attributes and ridem
DESCRIPTION3 =water quality feature attributes
ACC-REV-DATE =0100
DATA-STRUCTURE =vector polygon with annotation and feature attribs
COORD-PRECIS =arc-info single precision
INTENDED-USE =statewide mapping of ridem water quality
INTENDED-SCALE =24000
TRANSFER-FORMAT =arcinfo
TRANSFER-SIZE =4.3 megabytes
SPLOBJ-TYPE =polygon
RESOLUTION =na
SPLOBJ-COUNT =982 polygons
AREA-EXT-BND =ll-231400 24873 ur-430208 340712
AREA-EXCL-BND =contains major water bodies and double line rivers
PROJECTION =transverse mercator
COORDSYS-UNIT =ri state plane feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd29
REL-DB-ID =lakes.pat
REL-DB-ORG =ridem
FIELD-NAME1 =wq99
FIELD-CHAR1 =10 10 c
FIELD-DESC1 =ridem water quality codes
FIELD-DOM1 =a b b1 ba b1a
FIELD-ASSC1 =waterqual.ref
SOURCE-CRTR =ridem
SOURCE-ORIG1 =rigis major hydropolys coverage s44hhm91
SOURCE-ORIG2 =ridem water quality regulations
BIBLIOG-REF =ridem water quality regulations
SOURCE-SCAL =24000
SOURCE-DATE =0191
DATA-DATE =0900
AUTO-EQPT =workstation nt arc info
AUTO-PROC1 =polygons in s44hhm91 were coded for water quality
AUTO-PROC2 =as per ridem
AUTO-PROC3 =na

PROC-TOL =rigis standards
PROC-DATE =0999
POS-ACCU =plus or minus 50 feet
POS-ACCUCK =visual inspection of output maps
ATTR-ACCU =rigis standards 100 percent
ATTR-ACCUCK =inspection of attribute tables and maps
DATA-INTEG =topologically complete arcinfo polygon coverage
METADATA-LIST =0999-pj
CONTACT-TITLE =gis manager
CONTACT-ORG =ri dept of environmental management-gis program
CONTACT-ADDR =235 promenade street
CONTACT-CTYST =providence ri 02903
CONTACT-PHONE =401-222-2776 ext 4315
CONTACT-EMAIL =pjordan-at-dem.state.ri.us

RIDEM - Office of Water Resources / Water Quality Regulations
Attribute Name, Description
WQ99:
Class A - These waters are designated as a source of public drinking water supply, for primary and secondary contact recreational activities and for fish and wildlife habitat.
They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value. Class A waters used for public drinking water supply may
be subject to restricted recreational use by State and local authorities.

Class B - These waters are designated for fish and wildlife habitat and primary and secondary
contact recreational activities. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural
uses. These waters shall have good aesthetic value.

Class B1 - These waters are designated for primary and secondary contact recreational activities
and fish and wildlife habitat. They shall be suitable for compatible industrial processes and
cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses.
These waters shall have good aesthetic value. Primary contact recreational activities may be
impacted due to pathogens from approved wastewater discharges. However, all Class B criteria
must be met.

Class B{a} and Class B1{a} - These waters, while designated for the Class B or B1 uses listed
above, will likely be impacted by combined sewer overflows in accordance with approved CSO
Facilities Plans and in compliance with rule 19.E.1 of the Rhode Island Water Quality Regulations
and the Rhode Island CSO Policy. Therefore, primary contact recreational activities and fish and
wildlife habitat will likely be restricted.

RIGIS Land Use Metadata

```
RIGIS-CAT-ID      =town landuse
DATA-SET-IDENT    =rilu95
DISTRIB-NOTES     =Licensed RIGIS Data
THEME-KEYWORDS    =land use land cover
DATASET-DESC1     =Land use and land cover as originally interpreted
DATASET-DESC2     =from 1988 aerial photography and as updated from
DATASET-DESC3     =1992-1995 orthos-inclusive data s44wwt88
ACC-REV-DATE      =0299
DATA-STRUCTURE    =vector topological with feature attributes
COORD-PRECIS      =arc-info single precision
INTENDED-USE      =land use planning
INTENDED-SCALE    =24000
TRANSFER-FORMAT   =arc-info export
TRANSFER-SIZE     =
SPLOBJ-TYPE       =polygon
RESOLUTION        =one half acre
SPLOBJ-COUNT      =60102 polygons
AREA-EXT-BND      =ll-219335 22904 ur-432051 340916
AREA-EXCL-BND     =none
PROJECTION        =transverse mercator
COORDSYS-UNIT     = rispc us feet
HORIZ-DATUM       =NAD83
VERT-DATUM        =none
REL-DB-ID         =nn_lulcE.pat
REL-DB-ORG        =ridoa-swpp
ITM1-LUSTATE-ID   =code88
FIELD-CHAR1       =4 5 b
FIELD-DESC1       =lu code for same polygon in rigis lu 1988 data
FIELD-DOM1        =code 110-760
FIELD-ASSC1       =landuse.ref - text at end of this file
ITM2-CODE         =ch8895
FIELD-CHAR2       =4 5 8
FIELD-DESC2       =indicator of change from 1988 to 1995 rigis lu
FIELD-DOM2        =22-no change of 110-760 1995 land use code
FIELD-ASSC2       =landuse.ref
ITM3-ACRE/AREA    =acres
FIELD-CHAR3       =4 12 f 3
FIELD-DESC3       =lu polygon area by acres
FIELD-DOM3        =0.1-691000
FIELD-ASSC3       =landuse-rel
ITM4-NA           =code95
FIELD-CHAR4       =4 5 i
FIELD-DESC4       =anderson lu code for polygon for 1995
FIELD-DOM4        =111-760
FIELD-ASSC4       =landuse.ref-see text at end of metadata file
ITM5-NA           =descrpt
FIELD-CHAR5       =60 c
FIELD-DESC5       =description of land use for anderson code for 1995
FIELD-DOM5        =text
FIELD-ASSC5       =na
```

ITM6-NA	=type95
FIELD-CHAR6	=2 c
FIELD-DESC6	=umass landuse type code for graphic comparison
FIELD-DOM6	=text
FIELD-ASSC6	=landuse.ref
SOURCE-CRTR	=resource mapping center-umass at amherst
SOURCE-ORIG1	=1988 conventional bw aerial photography
SOURCE-ORIG2	=1995-1992 near ct border usgs ortho-photography
BIBLIOG-REF	=anderson et al
SOURCE-SCAL	=1988-24000 1995-12000
SOURCE-DATE	=1988 1992-ct border area 1995 interior ri and ma
DATA-DATE	=1988-1992-1995
AUTO-EQPT	=workstation arc info on
AUTO-PROC1	=1988 rigis lu was used as polygon base and updated
AUTO-PROC2	=from 1995 and 1992 usgs doqs-zts used to register
AUTO-PROC3	=mismatches in 1988 and 1995 data
PROC-TOL	=rigis standards rms-005 fuzzy-002
PROC-DATE	= 1998-1999
POS-ACCU	=plus or minus 50 feet
POS-ACCUCK	=visual inspection of overlays on mylar originals
ATTR-ACCU	=rigis standards 99 percent
ATTR-ACCUCK	=visual inspection of polygon coding
DATA-INTEG	=topologically complete arc-info polygon coverage
METADATA-LIST	=0299-jds
CONTACT-TITLE	=rigis coordinator
CONTACT-ORG	=ri dept of administration-planning
CONTACT-ADDR	=one capitol hill
CONTACT-CTYST	=providence ri 02908-5872
CONTACT-PHONE	=401-222-6483
CONTACT-EMAIL	=stach@rigis.doa.state.ri.us

RHODE ISLAND LAND USE AND LAND COVER CLASSIFICATION
LANDUSE.REF

ANDERSON CODE DESIGNATION	88/99 DESCRIPTION	UMASS Code
100 Urban or Built Up Land		
110 Residential		
111 High Density	>8 dwelling units /acre	U1
112 Medium High Density	4 to 7.9 dwelling units/acre	U2
113 Medium Density	1 to 3.9 dwelling units/acre	U3
114 Medium Low Density	.5 to .9 dwelling units/acre	U4
115 Low Density	< .5 dwelling units/acre	U5
120 Commercial & Services	primary sale of products and services	C
130 Industrial	manufacturing, design and assembly, finishing, etc. industrial parks	I
140 Transportation, Communications And Utilities		
141 Roads	divided highways with 200 feet or more of right of way width, interchanges, related terminals and parking	HW

142 Airports runways, terminals, parking, storage
TA
143 Railroads terminals, parking, repair areas RR
144 Water and Sewage Treatment Facilities
land and associated buildings FB
145 Waste Disposal Areas active landfills and junkyards
WD
146 Power Lines rights-of-way of 100 feet or more width
PL
147 Other water based transportation facilities.
Commercial docks TO
150 Mixed Urban light industrial and comercial uses
that can not be separated CI

160 Other Urban
161 Developed Recreational urban parks, zoos, stadiums, golf courses,
DR
playfields, marinas

162 Urban Open Sapce vacant land VC
163 Cemeteries cemetaries
170 Institutional education,health,correctional
religious, military, etc. UP

200 Agricultural Lands

210 Pasture hay fields, land not suitable for tillage AP
220 Cropland intensively farmed and tillable land
AC
230 Orchards, Groves, Nursuries WP
240 Confined Feeding Lots animal raising in confined areas CF
250 Idle Agriculture abandoned field and orchards etc. AI

300 Forest Land

310 Deciduous Forest 80% or greater diciduous species H
320 Evergreen Forest 80% or greater evergreen species S
330 Mixed Deciduous 50-80 deciduous dominand HS
340 Mixed Evergreen 50-80% evergreen species SH

400 Brushland shrub and brush areas, cut over areas
undergoing reforestation B

500 Water reservoirs,lakes and ponds W

600 Wetlands forested and non-forested area
WL

700 Barren Land

710 Beaches RW
720 Sandy Areas other than Beaches SD
730 Rock outcrops RO
740 Strip Mines, Quarries, & Gravel Pits M
750 Transitional Areas UO

Non-Community Wells Metadata

RIGIS-CAT-ID =s44hwn97
DATA-SET-IDENT =ncwells
DISTRIB-NOTES =(c)rigis 1989 licensed rigis data
THEME-KEYWORDS =public water supply noncommunity wells groundwater
DESCRIPTION1 =wells that serve as a public water supply system
DESCRIPTION2 =with at least 25 persons who are not permanent
DESCRIPTION3 =residents for more than 60 days a year
ACC-REV-DATE =0100
DATA-STRUCTURE =vector with feature attributes
COORD-PRECIS =arc-info single precision
INTENDED-USE =statewide geographically referenced inventory
INTENDED-SCALE =24000
TRANSFER-FORMAT =arcinfo export
TRANSFER-SIZE =0.4 mb
SPLOBJ-TYPE =point
RESOLUTION =na
SPLOBJ-COUNT =483
AREA-EXT-BND =ll-246006 30352 ur-429803 338776
AREA-EXCL-BND =only wells classified as ridem noncommunity wells
PROJECTION =transverse mercator
COORDSYS-UNIT =rispc-feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd29
REL-DB-ID =ncwells.pat
REL-DB-ORG =ridem-ridoh
FIELD-NAME1 =wellname
FIELD-CHAR1 =60 c
FIELD-DESC1 =name of facility or well as listed by ridoh-ridem
FIELD-DOM1 =text
FIELD-ASSC1 =ridem water rescources databases
FIELD-NAME2 =site-type
FIELD-CHAR2 =1 i
FIELD-DESC2 =ridem facility typed as transient or nontransient
FIELD-DOM2 =n-transient p-nontransient
FIELD-ASSC2 =ridem water resources databases
FIELD-NAME3 =source
FIELD-CHAR3 =8 c
FIELD-DESC3 =method used for obtaining well coordinate location
FIELD-DOM3 =ag-gps demw dmf dem-gps epa-gpsc epa-gpsuc
FIELD-ASSC3 =ncwells.ref
FIELD-NAME4 =material
FIELD-CHAR4 =6 c

FIELD-DESC4 =geologic material in which well is located
FIELD-DOM4 =b-bedrock sd-stratified drift
FIELD-ASSC4 =ridem water resources and rigis databases
FIELD-NAME5 =pump
FIELD-CHAR5 =5 i
FIELD-DESC5 =well pumping rate in gallons per minute
FIELD-DOM5 =10-223
FIELD-ASSC5 =ridem water resources and ridoh databases
FIELD-NAME6 =townname
FIELD-CHAR6 =17 c
FIELD-DESC6 =town in which well is located
FIELD-DOM6 =text
FIELD-ASSC6 =na
SOURCE-CRTR =ridoh-ridem
SOURCE-ORIG1 =ridoh database of public wells
SOURCE-ORIG2 =ridem and usgs lat-long files -epa ridem gps data
BIBLIOG-REF =ridem noncommunity wells document procedures files
SOURCE-SCAL =24000-usgs 7.5 minute quad maps
SOURCE-DATE =ridoh-1196 ridem and epa gps in 1996-1997
DATA-DATE =ridoh-1196 ridem epa gps in 1996-1997
AUTO-EQPT =workstation arcinfo trimble pathfinder gps
AUTO-PROC1 =coordinate locations of and wells from
AUTO-PROC2 =ridoh list were repositioned with gps in field
AUTO-PROC3 =some coordinate locations from s44hwn96
PROC-TOL =location tolerences varied-not to rigis standards
PROC-DATE =gps-1997
POS-ACCU =plus or minus 50 feet-worst case scaled from quads
POS-ACCUCK =visual inspection of overlay maps
ATTR-ACCU =rigis standards 99 perecent
ATTR-ACCUCK =visual inspection of attribute tables
DATA-INTEG =complete arcinfo point coverage
METADATA-LIST =0599-cpb and 0400-jds
CONTACT-TITLE =gis manager ridem
CONTACT-ORG =ri department of environmental management-planning
CONTACT-ADDR =235 promenade street
CONTACT-CTYST =providence ri 02903
CONTACT-PHONE =401-222-2776-x4315
CONTACT-EMAIL =pjordan-at-dem.state.ri.us

NCWELLS.REF - Attribute Coding Descriptions
for s44hwn97 - ncwells
RIDEM NonCommunity Wells for Public Water Supply Systems

SOURCE - Methods used for obtaining well coodinate locations

AG-LL - Uncorrected GPS Lat/Long value form RIDEM Agricultural Division

DEM(F) -RIDEM scaled Lat/Long position of facility on USGS 7.5 minute quad maps
no site visit verificaiton

DEM(W) - RIDEM scaled Lat/Long position of facility on USGS 7.5 minute quad maps
site visit verification

DEM-GPS - RIDEM differentionally corrected GPS Lat/Long values

EPA-GPS/C - GPS Coordinate location by USEPA contractor-differentially corrected

EPA-GPS/C - GPS Coordinate location by USEPA contractor-not differentially
corrected

Lakes and Ponds Metadata

RIGIS-CAT-ID =s44hhp88
DATA-SET-IDENT =esri-state-rihydrop
DISTRIB-NOTES =' ' (c)rigis-1989
THEME-KEYWORDS =lakes ponds rivers streams water bodies
DATASET-DESC1 =lakes ponds rivers and streams wide enough
DATASET-DESC2 =to be identified by polygon features
DATASET-DESC3 =islands shown in major water bodies
ACC-REV-DATE =1289
DATA-STRUCTURE =vector topological
COORD-PRECIS =arc-info single precision
INTENDED-USE =state wide water resource inventory and mapping
INTENDED-SCALE =24000
TRANSFER-FORMAT =arc-info export
TRANSFER-SIZE =8-0 mb
SPLOBJ-TYPE =polygon
RESOLUTION =one quarter acre
SPLOBJ-COUNT =4196
AREA-EXT-BND =LL 230866.141 24274.707 UR 431892.312 340712.469
AREA-EXCL-BND =none
PROJECTION =transverse mercator
COORDSYS-UNIT =RISPC-feet
HORIZ-DATUM =nad83
VERT-DATUM =ngvd 29
REL-DB-ID =rihydrop-pat
REL-DB-ORG =uri-edc
ITM1-RIHYDROP-ID=
FIELD-CHAR1 =4 5 B 0
FIELD-DESC1 =polygon identifier
FIELD-DOM1 =0-4195
FIELD-ASSC1 =
ITM2-ISLAND =island
FIELD-CHAR2 =3 3 C 0
FIELD-DESC2 =y or no island coding
FIELD-DOM2 =y-n
FIELD-ASSC2 =
ITM3-NA =na
FIELD-CHAR3 =na
FIELD-DESC3 =name
FIELD-DOM3 =na
SOURCE-CRTR =usgs
SOURCE-ORIG1 =usgs 7-5 minute mylar quad maps
SOURCE-ORIG2 =

BIBLIOG-REF =none
SOURCE-SCAL =24000
SOURCE-DATE =1976-1983
DATA-DATE =1988
AUTO-EQPT =prime mainframe arc-info
AUTO-PROC1 =water bodies wide enough to be identified as
AUTO-PROC2 =polygon features were manually digitized
AUTO-PROC3 =from tablets
PROC-TOL =rigis standards rms-005 fuzzy-002
PROC-DATE =1289
POS-ACCU =plus or minus 50 feet
POS-ACCUCK =inspection of overlay proofs with source
ATTR-ACCU =none
ATTR-ACCUCK =none
DATA-INTEG =topologically complete arc-info polygon coverage
METADATA-LIST =0998-js
CONTACT-TITLE =director uri-environ data center
CONTACT-ORG =uri dept of natural res sci-environmental data cnt
CONTACT-ADDR =university of rhode island 210b woodward hall
CONTACT-CTYST =kingston ri 02881
CONTACT-PHONE =401-222-6483
CONTACT-EMAIL =stach@rigis.doa.state.ri.us

Sewered Areas Metadata

RIGIS-CAT-ID =s44usa95
DATA-SET-IDENT =sewpol95
DISTRIB-NOTES =(c)rigis 1989
THEME-KEYWORDS =municipal public sewer areas
DESCRIPTION1 =areas served by municipal and regional public
DESCRIPTION2 =sewer systems as defined by polygons around
DESCRIPTION3 =main lines and interceptors
ACC-REV-DATE =0795
DATA-STRUCTURE =vector topological
COORD-PRECIS =arc-info single precision
INTENDED-USE =land use management and infrastructure inventory
INTENDED-SCALE =24000
TRANSFER-FORMAT =arc-info export
TRANSFER-SIZE =0-68 mb
SPLOBJ-TYPE =polygon
RESOLUTION =polygons greater than 10 acres
SPLOBJ-COUNT =261 polygons
AREA-EXT-BND =LL 234520.797 31856.578 UR 398674.438 340026.500
AREA-EXCL-BND =sewered areas not shown by lines in s44usl95
PROJECTION =transverse mercator
COORDSYS-UNIT =RISPC-feet
HORIZ-DATUM =nad83
VERT-DATUM =na
REL-DB-ID =sewpol95-pat
REL-DB-ORG =ri dept of admin-planning
FIELD-NAME1 =sewpol95-id
FIELD-CHAR1 =4 5 n
FIELD-DESC1 =polygon identifier label
FIELD-DOM1 =0-260
FIELD-ASSC1 =none
SOURCE-CRTR =rigis division of planning
SOURCE-ORIG1 =s44usl95-rigis data set of sewer lines
SOURCE-ORIG2 =na
BIBLIOG-REF =na
SOURCE-SCAL =various
SOURCE-DATE =1989 - revised for warwick 1994-li mi sk 1995
DATA-DATE =1995
AUTO-EQPT =workstation arc-info
AUTO-PROC1 =sewer lines in s44usl95 were buffered to 500 ft
AUTO-PROC2 =and inclusion donout exclusion areas less than
AUTO-PROC3 =10 acres were eliminated
PROC-TOL =rigis standards

PROC-DATE =0795
POS-ACCU =plus or minus 500 feet
POS-ACCUCK =visual display inspection of sewer line-areas
ATTR-ACCU =none
ATTR-ACCUCK =none
DATA-INTEG =topologically complete arc-info polygon coverage
METADATA-LIST =0998-js
CONTACT-TITLE =rigis coordinator planning
CONTACT-ORG =ri department of administration-planning
CONTACT-ADDR =one capitol hill
CONTACT-CTYST =providence ri 02908-5872
CONTACT-PHONE =401-222-6483
CONTACT-EMAIL =stach@rigis.doa.state.ri.us

Wetlands Metadata

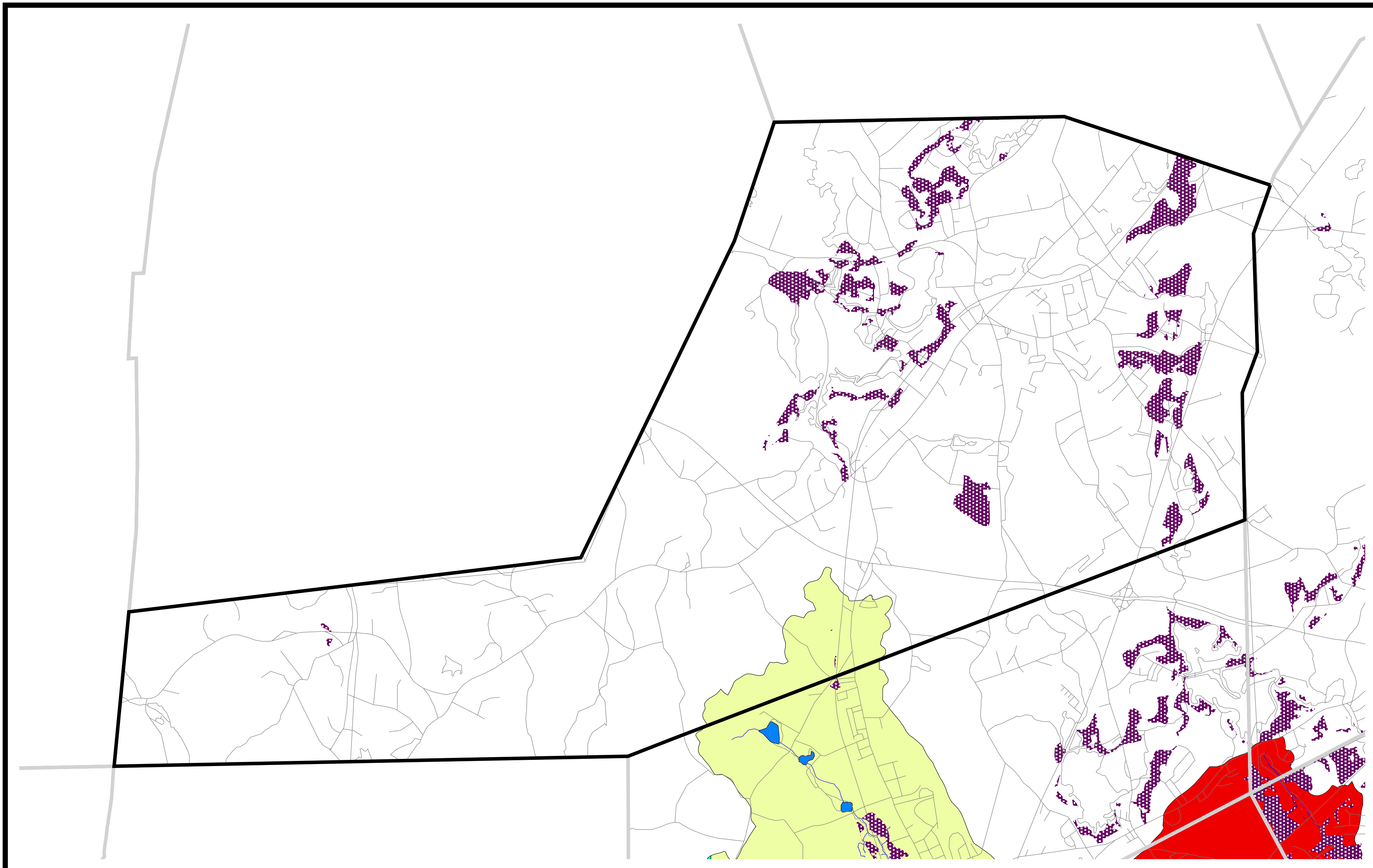
RIGIS-CAT-ID =town wetlands
DATA-SET-IDENT =riwet
DISTRIB-NOTES =(c)rigis-1989
THEME-KEYWORDS =wetland pond lake marsh fen bog water shore
DATASET-DESC1 =wetlands from aerial interpretation as coded by
DATASET-DESC2 =wetland and open water type for regional
DATASET-DESC3 =type locational areas
ACC-REV-DATE =1093
DATA-STRUCTURE =vector topological with feature attributes
COORD-PRECIS =arc-info single precision
INTENDED-USE =natural resource inventroy and land use planning
INTENDED-SCALE =24000
TRANSFER-FORMAT =arc-info export
TRANSFER-SIZE =
SPLOBJ-TYPE =polygon
RESOLUTION =one quarter acre
SPLOBJ-COUNT =30476
AREA-EXT-BND =LL 219275.125 22718.789 UR 432045.312 340916.594
AREA-EXCL-BND =none
PROJECTION =transverse mercator
COORDSYS-UNIT =RISPC-feet
HORIZ-DATUM =nad83
VERT-DATUM =none
REL-DB-ID =nn_wetE.pat
REL-DB-ORG =ridem
ITM1-NEAST-ID =
FIELD-CHAR1 =4 5 B 0
FIELD-DESC1 =polygon identifier
FIELD-DOM1 =50001-54934
FIELD-ASSC1 =none
ITM2-CODE =
FIELD-CHAR2 =3 3 I 0
FIELD-DESC2 =wetlands types
FIELD-DOM2 =1-16 inclusive and upland 99
FIELD-ASSC2 =wetland.rel
ITM3-WET-CHAR =
FIELD-CHAR3 =8 8 C 0
FIELD-DESC3 =3 letter wetland type abbreviation code
FIELD-DOM3 =text
FIELD-ASSC3 =wetland.ref
ITM4-JURIS =
FIELD-CHAR4 =5 5 C 0

```
FIELD-DESC4     =regional location identifier
FIELD-DOM4      =i c u
FIELD-ASSC4     =wetland.ref
FIELD-ASSC6     =na
SOURCE-CRTR     =iep inc
SOURCE-ORIG1    =1-24000 b-w aerial photography
SOURCE-ORIG2    =usgs quad based mylar sheets
BIBLIOG-REF     =cowardin et al 1979
SOURCE-SCAL     =24000
SOURCE-DATE     =april 1988
DATA-DATE       =1993 uri-edc
AUTO-EQPT       =workstation arc-info
AUTO-PROC1      =wetlands identified on photos were manually
AUTO-PROC2      =transferred onto mylar sheets and manually digitized
AUTO-PROC3      =tablets-projected to NAD83 by RIGIS in 1999
PROC-TOL        =rigis standards rms-005 fuzzy-002
PROC-DATE       =orig-1990 revised 1093
POS-ACCU        =plus or minus 75 feet
POS-ACCUCK      =manual graphic overlay comparison with source
ATTR-ACCU       =rigis standards 99 percent
ATTR-ACCUCK     =visual inspection with source
DATA-INTEG      =topologically complete arc-info polygon coverage
METADATA-LIST   =0998-js
CONTACT-TITLE   =ridem gis coordinator
CONTACT-ORG     =ri dept of environ mngt-water resources
CONTACT-ADDR    =291 promenade street
CONTACT-CTYST   =providence ri 02908
CONTACT-PHONE   =401-222-6483
CONTACT-EMAIL   =stach@rigis.doa.state.ri.us

/* -------------------- ITEMS --------------------------------------
 COL  ITEM NAME        WDTH OPUT TYP N.DEC  ALTERNATE NAME
   1  CODE               3    3  I     -
   4  WET-CHAR           3    3  C     -
   7  JURIS              1    1  C     -
   8  NAME              50   50  C     -
/* ------------------------------------------------------------------


$RECNO   CODE WET-CHAR JURIS NAME
     1     1  ROW      I     RIVERINE NONTIDAL OPEN WATER
     2     2  LOW      I     LACUSTRINE OPEN WATER
     3     3  POW      I     PALUSTRINE OPEN WATER
     4     4  EMA      I     EMERGENT WETLAND: MARSH/WET MEADOW
     5     5  EMB      I     EMERGENT WETLAND: EMERGENT FEN OR BOG
```

6	6	SSA	I	SCRUB-SHRUB WETLAND: SHRUB SWAMP
7	7	SSB	I	SCRUB-SHRUB WETLAND: SHRUB FEN OR BOG
8	8	FOA	I	FORESTED WETLAND: CONIFEROUS
9	9	FOB	I	FORESTED WETLAND: DECIDUOUS
10	10	FOD	I	FORESTED WETLAND: DEAD
11	11	RTW	C	RIVERINE TIDAL OPEN WATER
12	12	EOW	C	ESTUARINE OPEN WATER
13	13	ERS	C	MARINE/ESTUARINE ROCKY SHORE
14	14	EUS	C	MARINE/ESTUARINE UNCONSOLIDATED SHORE
15	15	EEM	C	ESTUARINE EMERGENT WETLAND
16	16	ESS	C	ESTUARINE SCRUB-SHRUB WETLAND
17	99	UPL	U	UPLAND

APPENDIX I

Potential Future Water Supply Exploration



Legend

- Wrentham
- Towns
- Potential Areas for Water Supply Exploration
- Ponds
- Streams
- Roads

Sub-Watersheds

- Bungay River
- Upper Ten Mile

N

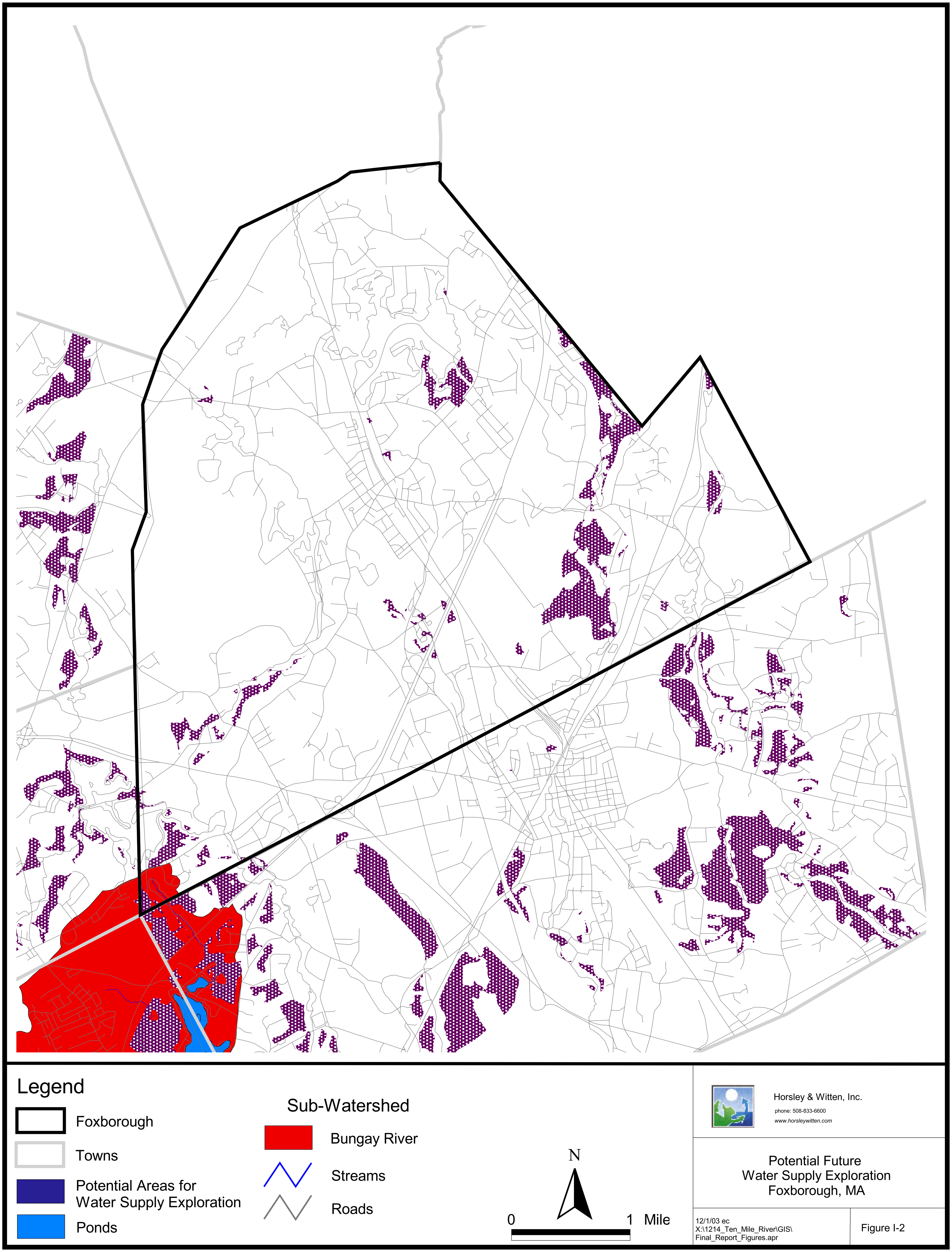
0 1 Mile

Horsley & Witten, Inc.
phone: 508-833-6600
www.horsleywitten.com

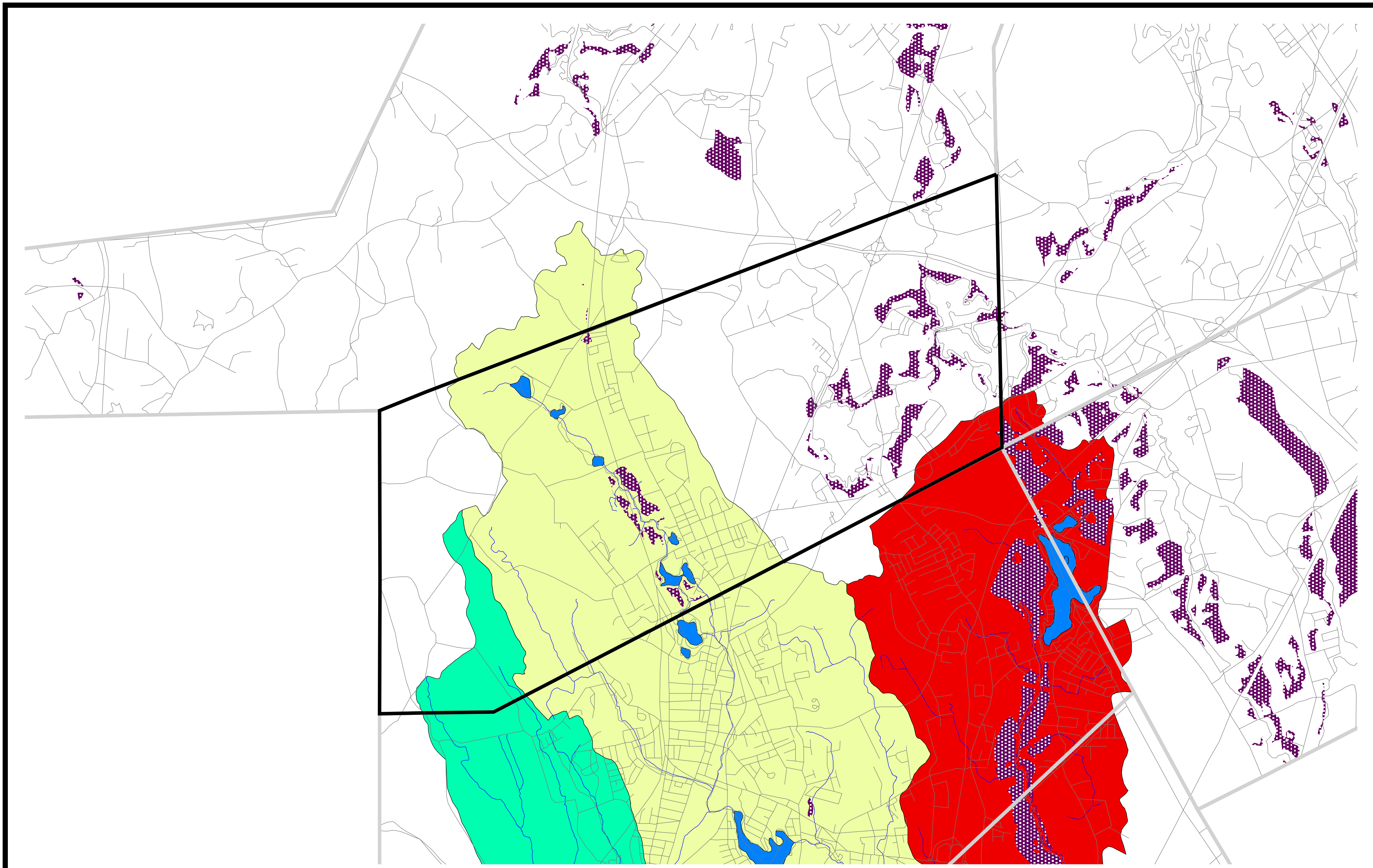
Potential Future
Water Supply Exploration
Wrentham, MA

12/1/03 ec
X:\1214_Ten_Mile_River\GIS\
Final_Report_Figures.apr

Figure I-1



Legend
Foxborough
Towns
Potential Areas for Water Supply Exploration
Ponds
Sub-Watershed
Bungay River
Streams
Roads
N
0
1 Mile
Horsley & Witten, Inc.
phone: 508-833-6600
www.horsleywitten.com
Potential Future
Water Supply Exploration
Foxborough, MA
12/1/03 ec
X:\1214_Ten_Mile_River\GIS\
Final_Report_Figures.apr
Figure I-2



Legend

- Plainville
- Towns
- Potential Areas for Water Supply Exploration
- Ponds
- Streams
- Roads

Sub-Watersheds

- Bungay River
- Seven Mile
- Upper Ten Mile

N

0 1 Mile

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Potential Future
Water Supply Exploration
Plainville, MA

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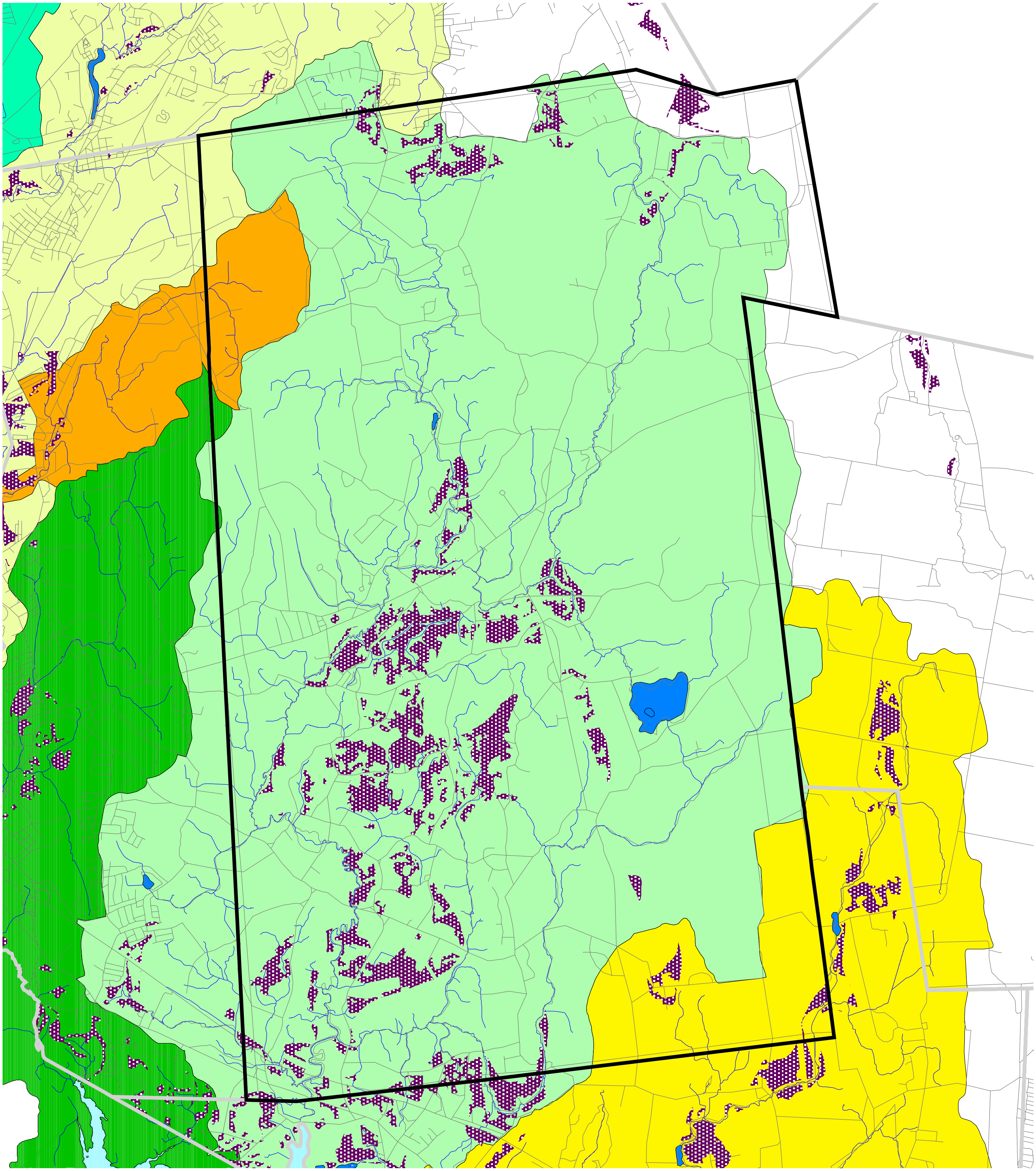
Final_Report_Figures.apr

Figure I-3



Legend

- Rehoboth
- Towns
- Potential Areas for Water Supply Exploration
- Roads

Sub-Watersheds

- Cole River
- Coles Brook
- Runnins River
- Seven Mile
- Upper Ten Mile
- W. Branch Palmer River
- Streams
- Ponds
- Ocean

N

0 1 Miles

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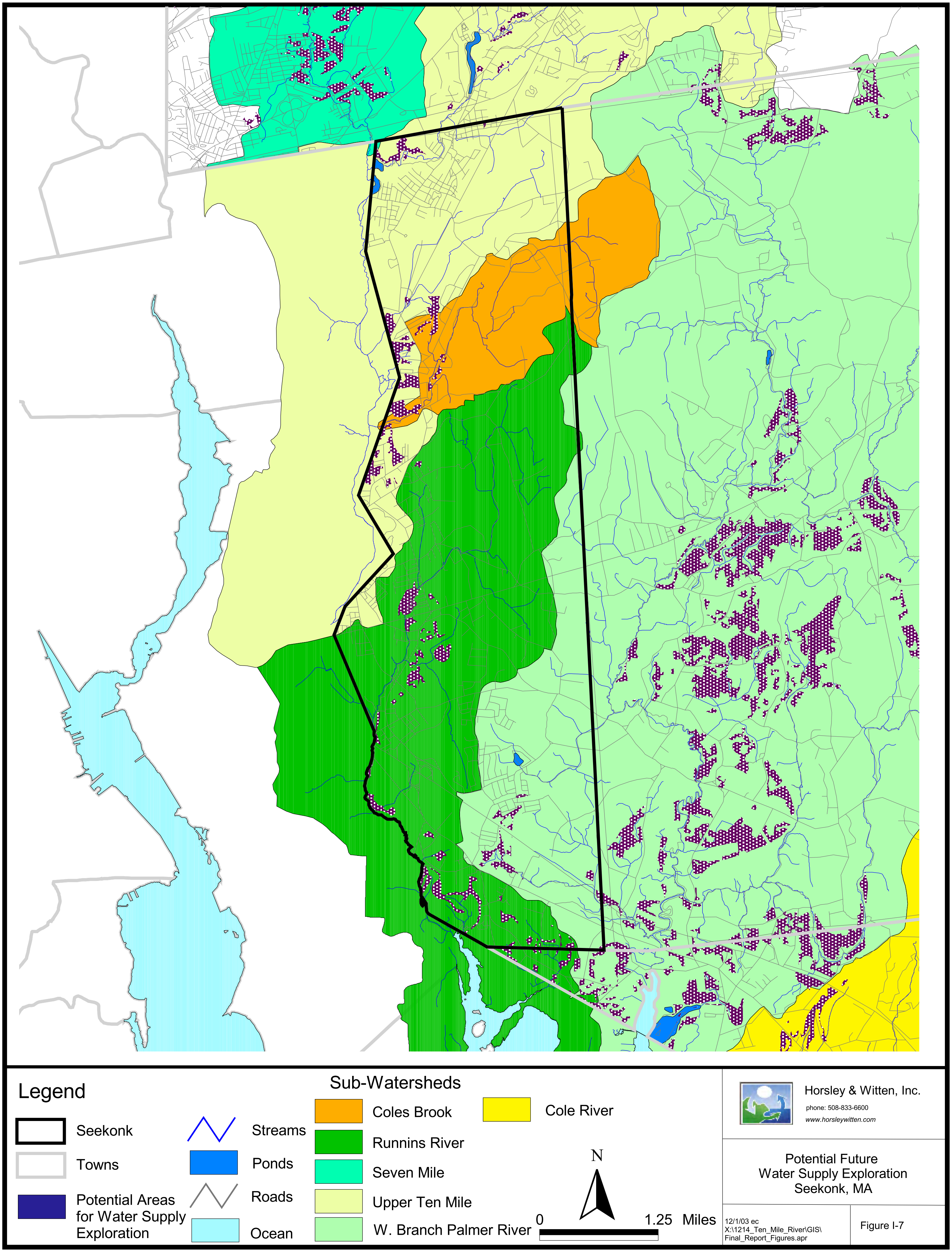
Potential Future Water Supply Exploration
Rehoboth, MA

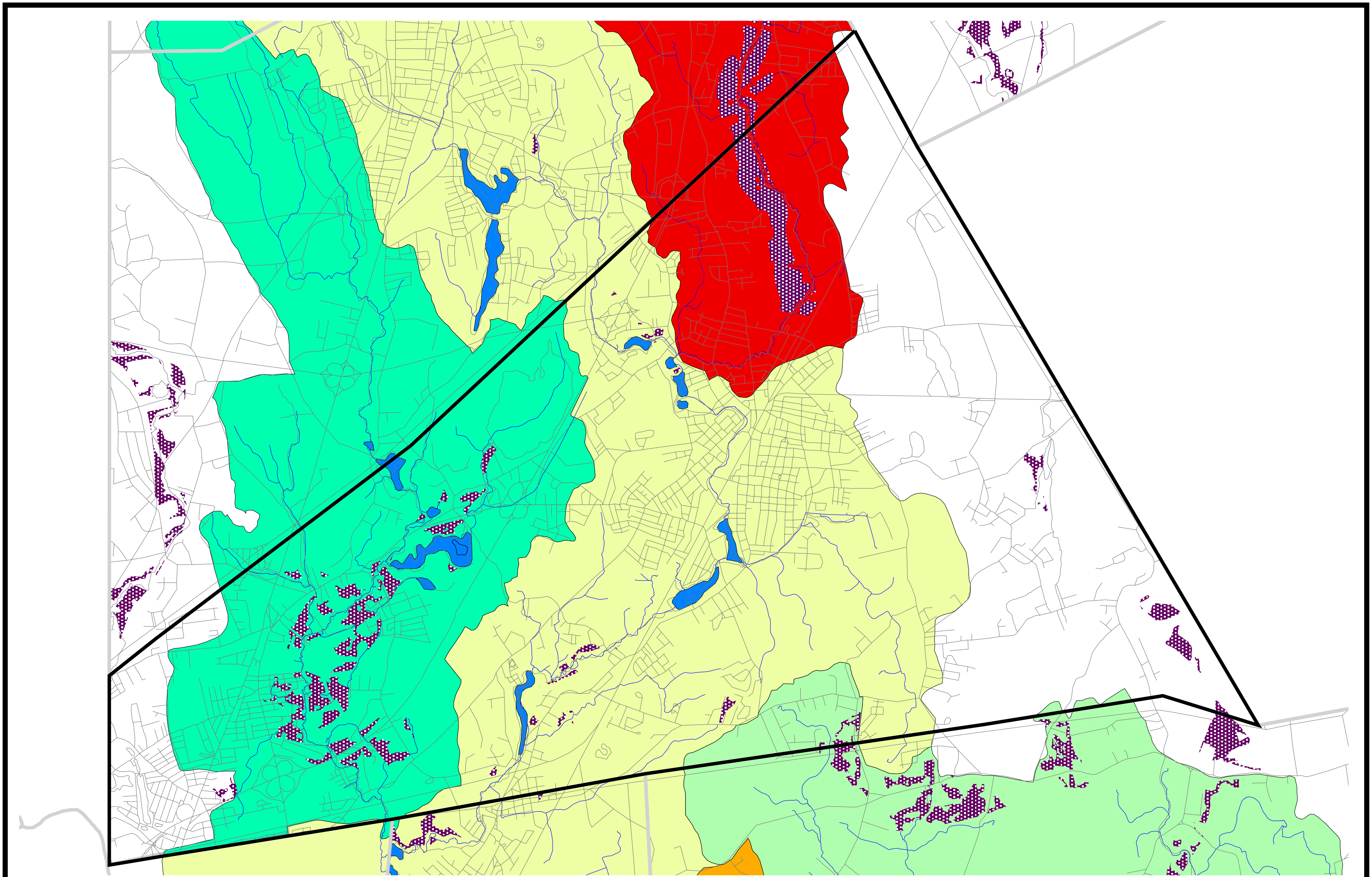
12/1/03 ec
X:\1214_Ten_Mile_River\GIS\Final_Report_Figures.apr

Figure I-8



Potential Future Water Supply Exploration Seekonk, MA

Figure I-7



Legend

- Attleboro
- Towns
- Potential Areas for Water Supply Exploration
- Streams
- Ponds
- Streets

Sub-Watersheds

- Bungay River
- Coles Brook
- Seven Mile
- Upper Ten Mile
- W. Branch Palmer River

N

0 1 Mile

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Potential Future
Water Supply Exploration
Attleboro, MA

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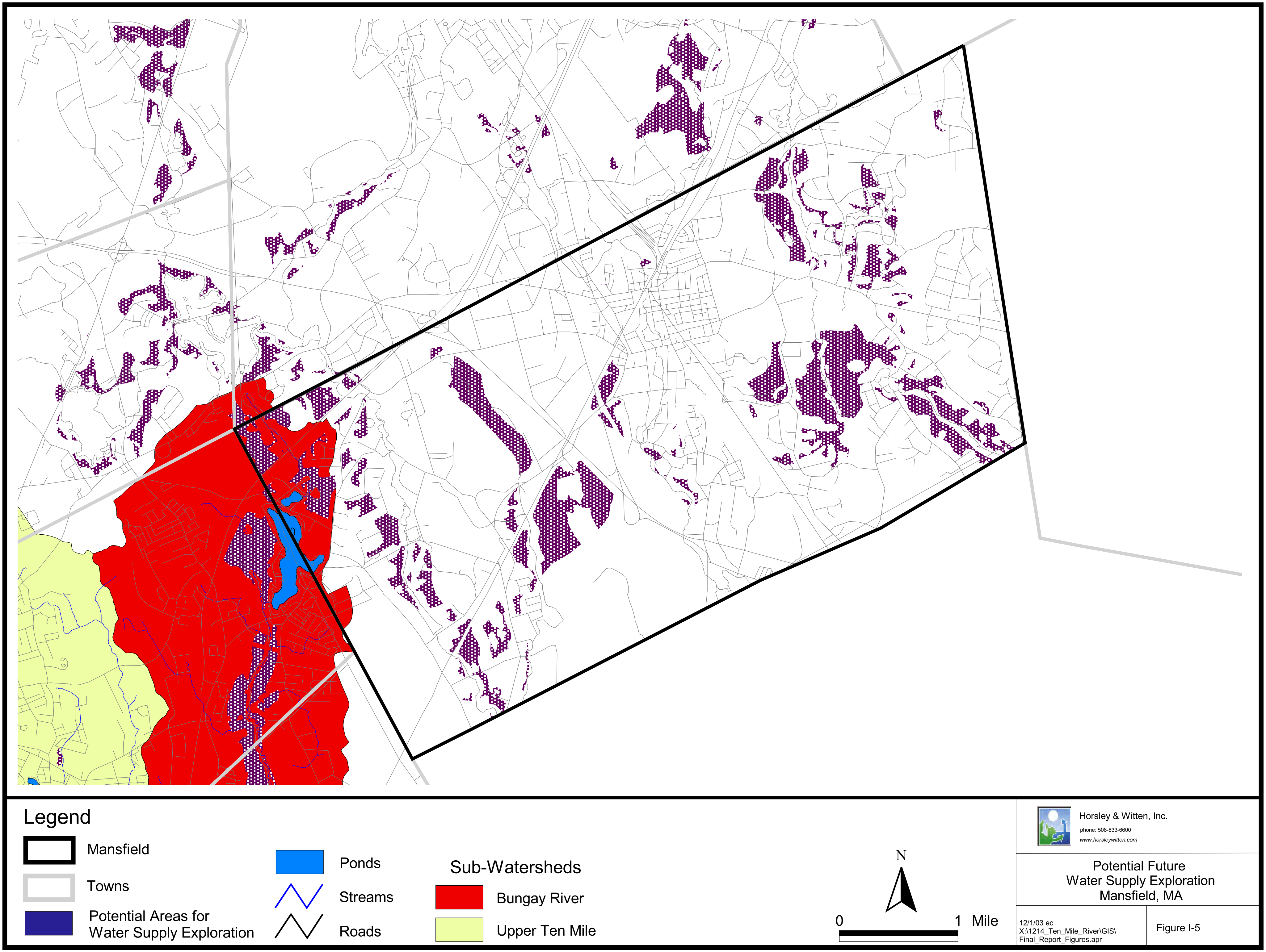
Figure I-6


Legend
Mansfield
Towns
Potential Areas for Water Supply Exploration
Ponds
Streams
Roads
Sub-Watersheds
Bungay River
Upper Ten Mile
N
0
1 Mile
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Potential Future
Water Supply Exploration
Mansfield, MA
12/1/03 ec
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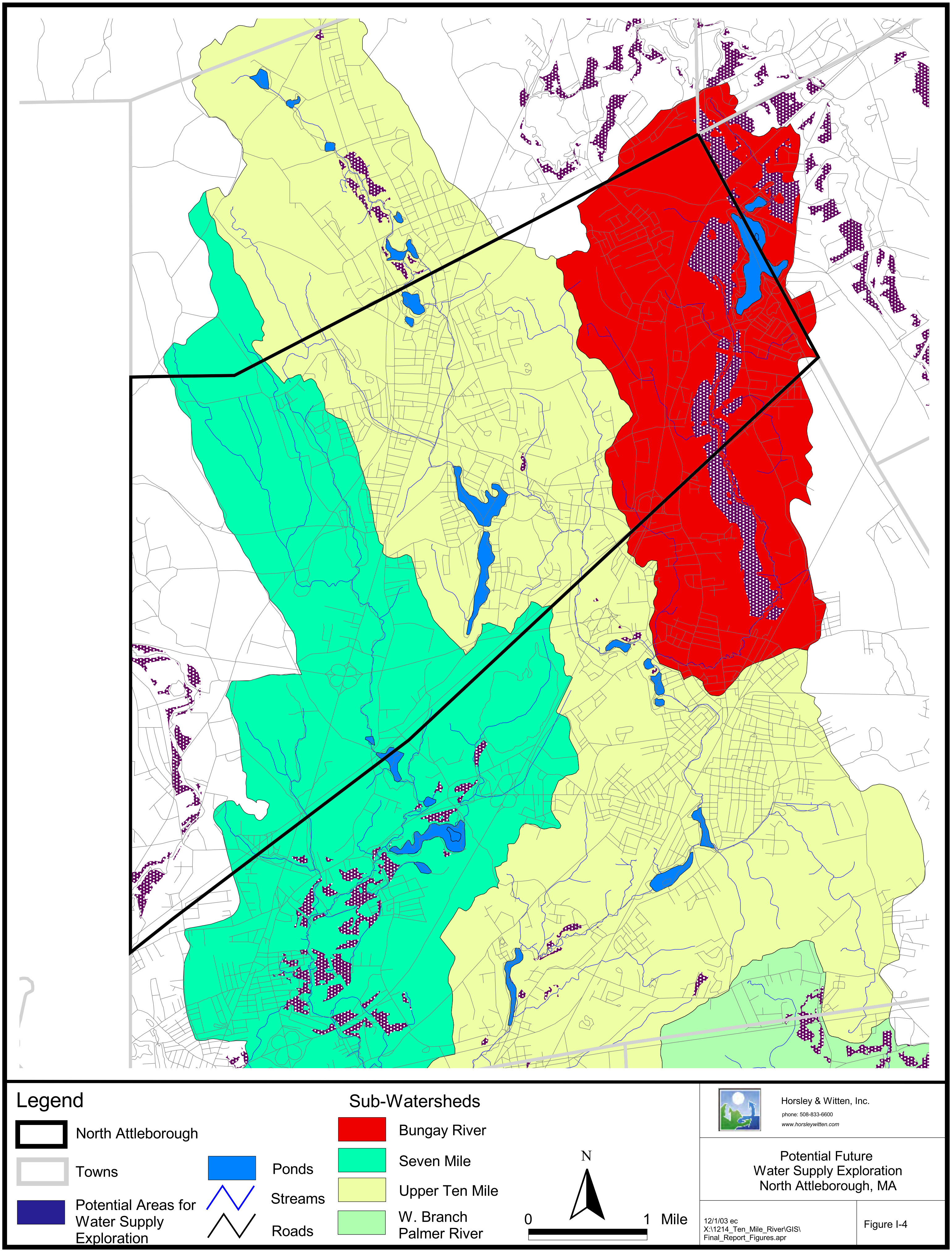
Final_Report_Figures.apr
Figure I-5



Legend
North Attleborough
Towns
Potential Areas for Water Supply Exploration
Ponds
Streams
Roads
Sub-Watersheds
Bungay River
Seven Mile
Upper Ten Mile
W. Branch Palmer River
N
0
1 Mile
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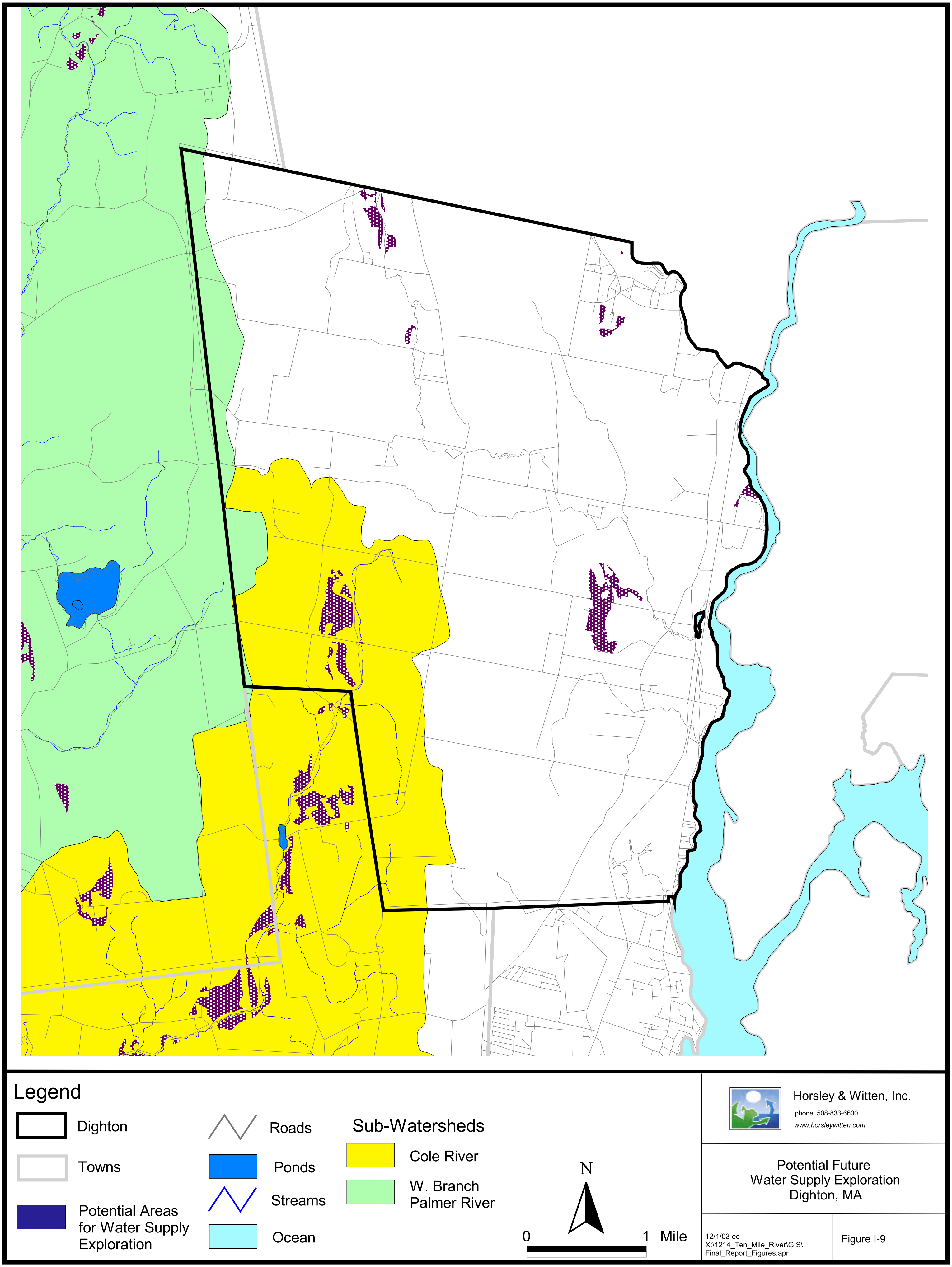
Final_Report_Figures.apr
Figure I-4



Legend
Dighton
Towns
Potential Areas for Water Supply Exploration
Roads
Ponds
Streams
Ocean
Sub-Watersheds
Cole River
W. Branch Palmer River
N
0
1 Mile
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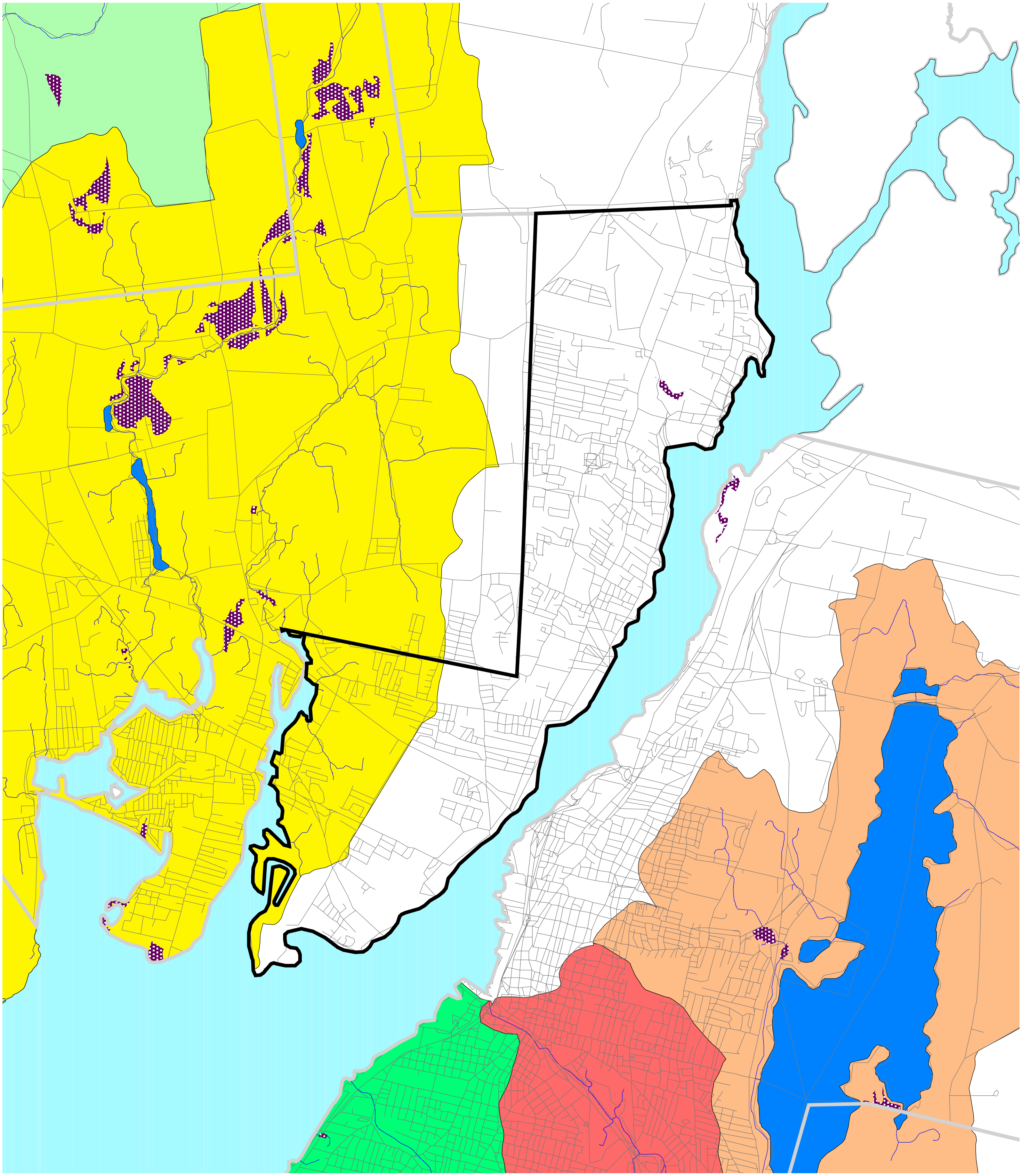
Potential Future
Water Supply Exploration
Dighton, MA
12/1/03 ec
X:\1214_Ten_Mile_River\GIS\
Final_Report_Figures.apr
Figure I-9



Legend

Somerset	Roads	
Towns	Ponds	
Potential Areas for Water Supply Exploration	Streams	
	Oceans	

Sub-Watersheds

- Cole River
- Cook/ Townsend Hills
- North Watuppa Pond
- Quequechan River
- W. Branch Palmer River

N

0 1 Mile

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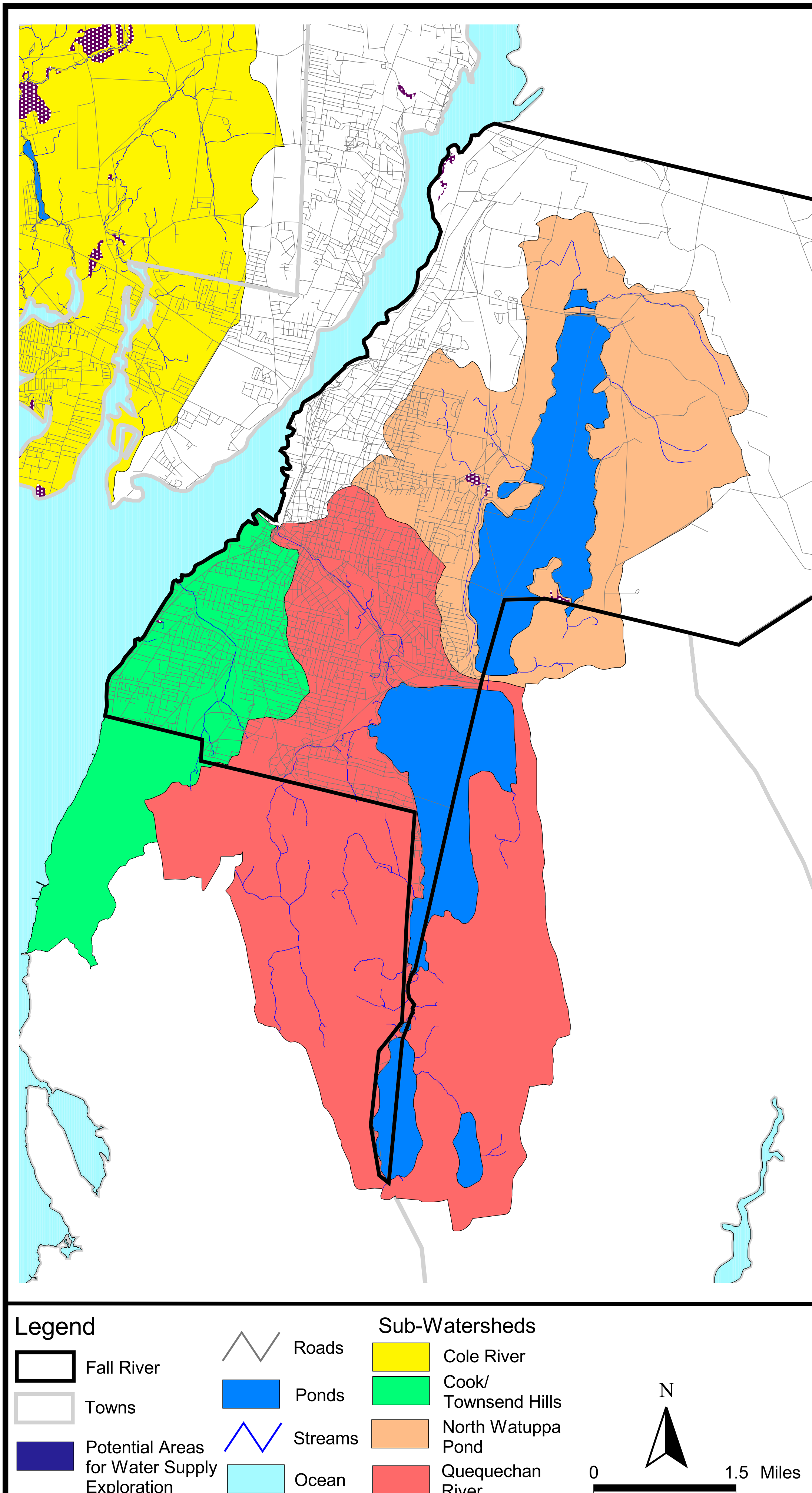
Potential Future Water Supply Exploration
Somerset, MA

12/1/03 ec
X:\1214_Ten_Mile_River\GIS\Final_Report_Figures.apr

Figure I-10



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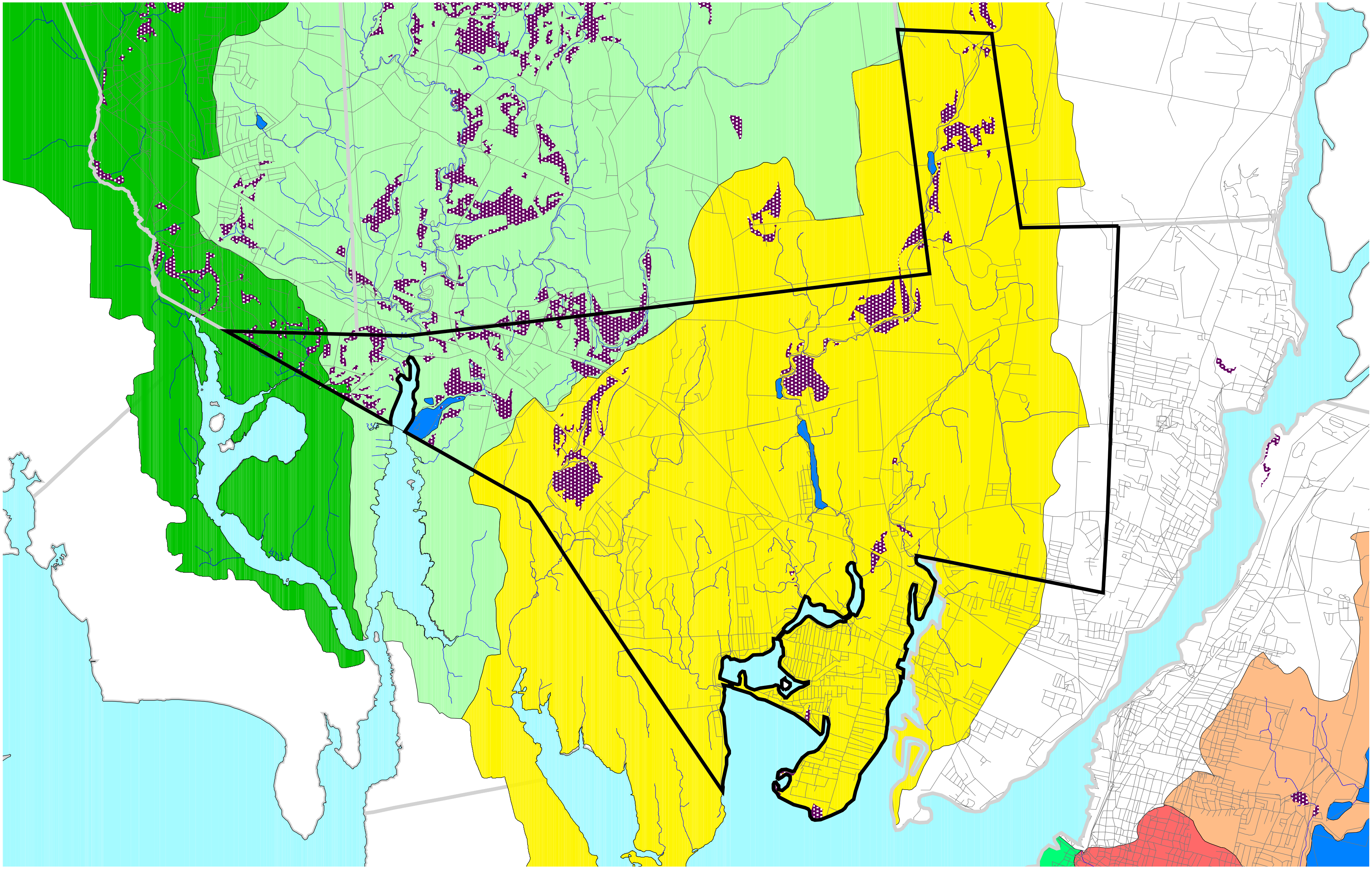
Potential Future
Water Supply Exploration
Fall River, MA

12/1/03 ec
X:\1214_Ten_Mile_River\GIS\
Final_Report_Figures.apr

Figure I-11



Legend

- Swansea
- Towns
- Potential Areas for Water Supply Exploration
- Roads
- Streams
- Ponds
- Ocean

Sub-Watersheds

- Cole River
- Runnins River
- North Watuppa Pond
- Quequechan River
- W. Branch Palmer River
- Cook/Townsend Hills

N

0 1.25 Miles

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Potential Future
Water Supply Exploration
Swansea, MA

12/1/03 ec
X:\1214_Ten_Mile_River\GIS\
Final_Report_Figures.apr

Figure I-12

APPENDIX J

Obtaining Streamflow Statistics for Massachusetts Streams on the World Wide Web

science for a changing world

Obtaining Streamflow Statistics for Massachusetts Streams on the World Wide Web

A World Wide Web application has been developed to make it easy to obtain streamflow statistics for user-selected locations on Massachusetts streams. The Web application, named STREAMSTATS (available at http://ma.water.usgs.gov/streamstats/), can provide peak-flow frequency, low-flow frequency, and flow-duration statistics for most streams in Massachusetts. These statistics describe the magnitude (how much), frequency (how often), and duration (how long) of flow in a stream.

The U.S. Geological Survey (USGS) has published streamflow statistics, such as the 100-year peak flow, the 7-day, 10-year low flow, and flow-duration statistics, for its data-collection stations in numerous reports. Federal, State, and local agencies need these statistics to plan and manage use of water resources and to regulate activities in and around streams. Engineering and environmental consulting firms, utilities, industry, and others use the statistics to design and operate water-supply systems, hydropower facilities, industrial facilities, wastewater treatment facilities, and roads, bridges, and other structures. Until now, streamflow statistics for data-collection stations have often been difficult to obtain because they are scattered among many reports, some of which are not readily available to the public. In addition, streamflow statistics are often needed for locations where no data are available. STREAMSTATS helps solve these problems.

STREAMSTATS was developed jointly by the USGS and MassGIS, the State Geographic Information Systems (GIS) agency, in cooperation with the Massachusetts Departments of Environmental Management and Environmental Protection. The application consists of three major components: (1) a user interface that displays maps and allows users to select stream locations for which they want streamflow statistics (fig. 1), (2) a data base of previously published streamflow statistics and descriptive information for 725 USGS data-collection stations, and (3) an automated procedure that determines characteristics of the land-surface area (basin) that drains to the stream and inserts those characteristics into equations that estimate the streamflow statistics. Each of these components is described and guidance for using STREAMSTATS is provided below.

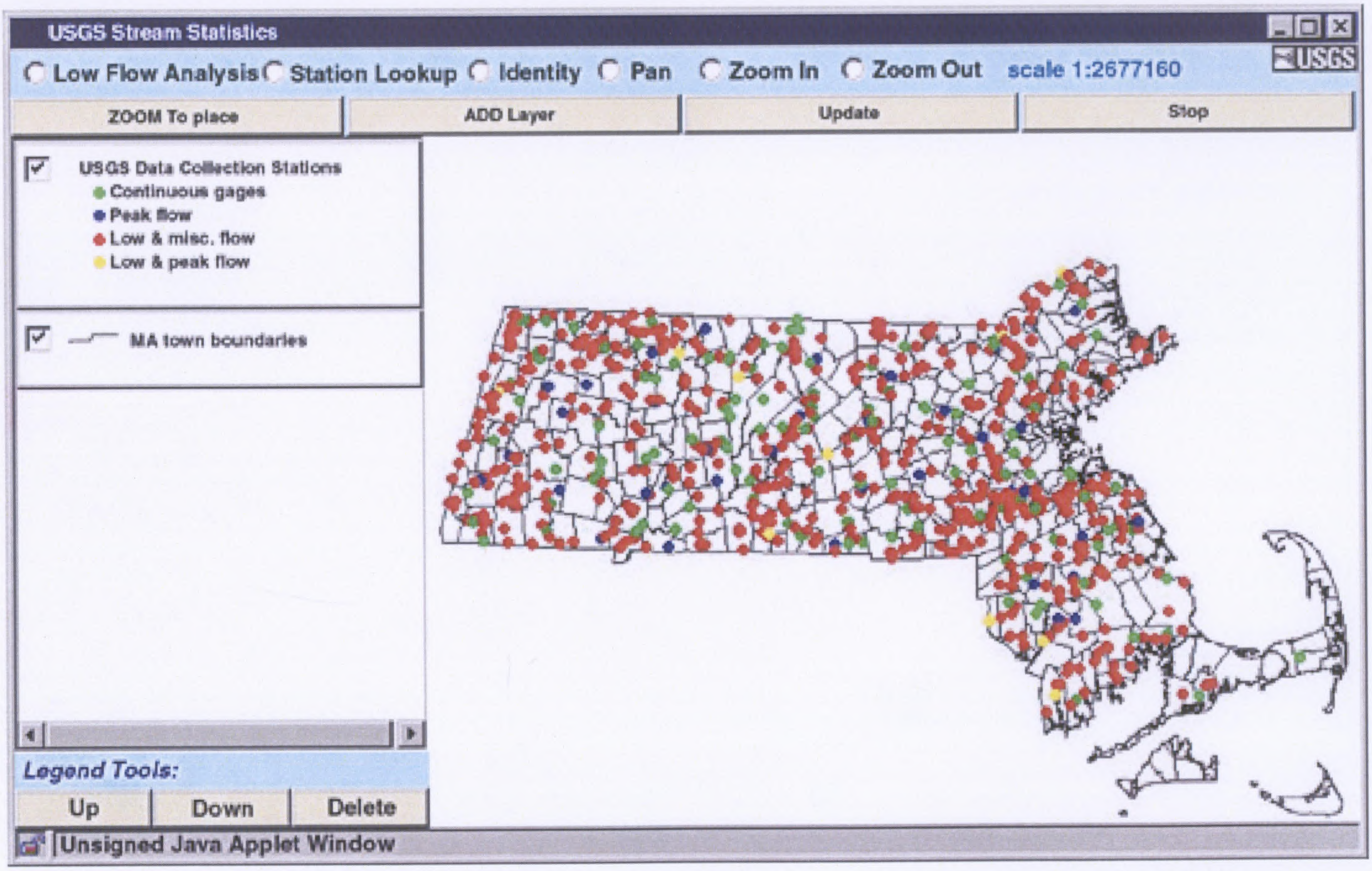


Figure 1. View of the STREAMSTATS-user interface at start up with the map window showing town boundaries and data-collection stations in Massachusetts.

STREAMFLOW STATISTICS FOR DATA-COLLECTION STATIONS

The USGS operates or has operated four types of streamflow-data-collection stations in Massachusetts: (1) continuous-record stations, (2) peak-flow partial-record stations, (3) low-flow partial-record stations, and (4) miscellaneous-measurement stations. A network of 74 streamgaging stations is currently (2000) operated in the State. Continuous records of streamflow of various length are available for these stations and for 79 streamgaging stations that were previously operated. Networks of peak-flow and low-flow partial-record stations were previously operated throughout the State, although none are currently in operation. Streamflow and water-level measurements were obtained occasionally over a period of years at the partial-record stations to determine either peak- or low-flow statistics for those stations. Streamflow data also have been collected at hundreds of miscellaneous-measurement stations. These stations were operated primarily for specific hydrologic studies with various objectives.

All streamflow data collected by the USGS in Massachusetts are stored in the USGS National Water Information System (NWIS) data base. This data base also contains descriptive information for each data-collection station. Data from NWIS were used to determine streamflow statistics for the 725 stations included in the STREAMSTATS database. Many other stations are not in the STREAMSTATS database, either because not enough data were available to accurately compute the statistics, or the flows were affected by human activities.

The STREAMSTATS data base is much smaller and faster to operate over the Web than the NWIS data base. Descriptive information was loaded from NWIS into the STREAMSTATS data base for all stations. Descriptive information includes USGS station identification number, station name, station type, period of record, latitude and longitude, hydrologic unit code, major drainage basin name, directions to locate the station, and remarks indicating effects of human activities on the flow or other pertinent information about the station.

Basin characteristics and streamflow statistics were entered into the STREAMSTATS data base for all stations for which these data were available. Available basin characteristics include drainage-basin area (the land surface-area that contributes streamflow to the location), area of stratified drift (coarse-grained sand and gravel areas where aquifers are usually located), area of water bodies (lakes, ponds, and wide streams), and area of wetlands, all in square miles; total length of streams, in miles; mean basin slope, in percent; and minimum, mean, and maximum basin elevations, in feet. Available peak-flow frequency statistics include the mean annual flood, and the 10-, 25-, 50-, 100-, and 500-year recurrence interval floods. Available low-flow frequency statistics include the 7-day, 2-year and the 7-day, 10-year recurrence interval low flows. Available flow-duration statistics include streamflows at selected durations exceeded between 99 and 1 percent of the time, and the August median streamflow. Definitions of these statistics are provided in the Web page for the application.

Not all of the streamflow statistics are available for all sites. Only peak-flow frequency statistics are likely to be available for peak-flow partial-record stations, whereas only low-flow frequency and low-flow duration statistics are likely to be available for low-flow partial-record stations. Streamgaging stations may have all available statistics or only a portion of them. Miscellaneous-measurement stations may have any of the statistics, but most of them have only low-flow statistics; thus most of these stations have been grouped with the low-flow partial-record stations in the database. In addition, many stations have few or no basin characteristics available. All statistics for the stations in the STREAMSTATS database were published previously in USGS reports, and the methods used to determine the statistics are described in those reports. Citations are provided along with each streamflow statistic served.

STREAMFLOW STATISTICS FOR LOCATIONS WHERE NO DATA ARE AVAILABLE

The USGS has developed equations that can be used to estimate various streamflow statistics for locations on Massachusetts streams where no data are available (Ries and Friesz, 2000). The equations were derived by regression analysis, which statistically relates the streamflow statistics for a group of data-collection stations to physical characteristics of the drainage basins for the stations. Physical characteristics for a site where no data are available can be measured and inserted into the regression equations to obtain estimates of the streamflow statistics for the site.

Regression analysis has been used to develop equations for estimating streamflow statistics in many other areas; however, use of the equations has been limited because measuring the physical characteristics needed to solve the equations has been difficult and time-consuming, and the equations are complex for some users. Historically, most physical characteristics were measured by hand from various maps. This process could take from several hours to days to complete for a single site. In addition, many of the maps were not widely circulated, and many potential users did not possess the equipment or expertise necessary to measure the values from the maps. STREAMSTATS eliminates these problems by automating the process of measuring the physical characteristics and solving the equations. As a result, users can now obtain streamflow statistics for selected locations within a few minutes.

The STREAMSTATS low-flow analysis procedure measures physical characteristics for user-selected locations from digital map data using ArcView[1] GIS (Environmental Systems Research Institute, Inc., 1996a), and its accompanying programming language, AVENUE (Environmental Systems Research Institute, Inc., 1996b). STREAMSTATS does not require knowledge of how to use a GIS; users simply select the location of interest from a map displayed in the user interface, and STREAMSTATS does the rest.

After the user selects a site of interest from the map, STREAMSTATS determines the drainage-basin boundary and area. This is done using a combination of two sets of digital map data, known as data layers. One data layer contains drainage-basin boundaries for about 2,300 locations on Massachusetts streams, an average of one set of boundaries for every 4 square miles of land surface in the State. The other data layer is a Digital Elevation

[1]Use of trade or product names is for identification purposes only, and does not constitute endorsement by the U.S. Geological Survey.

Model (DEM), developed by the USGS at 1:25,000 scale, that consists of a rectangular grid of elevation points spaced approximately every 100 feet along the land surface (Elassel and Caruso, 1983). The DEM elevations correspond to elevations shown on 1:25,000-scale USGS topographic quadrangle maps. If the user selects a site on an existing drainage-basin boundary, the area associated with that boundary is summed with areas for all upstream subbasins to determine the total drainage-basin area for that site. If the user selects a site not on an existing boundary, STREAMSTATS uses the DEM to define the boundary up to points at which the newly defined boundary coincides with existing boundaries. From that point, the existing boundaries are used to determine the total drainage-basin boundary and area for the site.

After STREAMSTATS determines the drainage-basin boundary, it then determines the remaining basin characteristics needed to solve the regression equations from other digital map layers: total length of streams, area of surficial stratified drift, mean basin slope, and hydrologic region. This process is more fully explained by Ries and Friesz (2000). STREAMSTATS then solves the regression equations and provides estimated streamflow statistics for the site to the user. Equations are available to estimate the 7-day, 2-year and the 7-day, 10-year recurrence-interval low flows; streamflows exceeded 99-, 98-, 97-, 95-, 90-, 75-, and 50-percent of the time; and the August median streamflow. STREAMSTATS also calculates prediction intervals at the 90-percent confidence level for the estimates as an indication of their reliability. The true values of the streamflow statistics for the selected sites are within the provided intervals 90 percent of the time.

MassGIS employees did much of the programming for the STREAMSTATS automated procedure and developed many of the digital map layers it uses. The MassGIS Watershed Analyst tool includes some of the features of this application and also includes several additional features. The Watershed Analyst tool, the map layers used by STREAMSTATS, and their descriptions are available through the MassGIS Web page (http://www.state.ma.us/mgis/).

USING STREAMSTATS

The STREAMSTATS user interface was developed for the USGS by Syncline, Inc., of Cambridge, Mass. The user interface is a Java applet (Sun Microsystems, Inc., 1999) that delivers interactive maps to users by use of the Internet Map Server software extension to ArcView (Environmental Systems Research Institute, Inc., 1999). Maps delivered over the Web can be used to select sites for which streamflow statistics will be provided. The applet incorporates a map window, a map legend window, a map action toolbar, and a menu command toolbar (fig. 1).

First-time users of STREAMSTATS start on an introductory page, and are led through seven tutorial pages that provide instructions before they can start the applet. The introductory page also contains a link that allows users to view an on-line demonstration to help them become familiar with the application. Experienced users can bypass the tutorial on return visits and go to the main entry page for the application. The main entry page contains links to the tutorial pages for reference and a GO button that activates the user interface.

The user interface initially displays a map of Massachusetts in the map window with town boundaries and locations of data-collection stations (fig. 1). Buttons in the toolbars allow users to zoom in, zoom out, and pan to change the area displayed; to add, delete, and change the drawing order of map layers; and to identify features on the map. More than 100 map layers can be displayed to aid in locating sites of interest. The legend window identifies the displayed map layers.

The tutorial pages provide guidance on selecting map layers for locating sites. Usually, only a few map layers are needed. These usually include some combination of watershed boundaries, roads, stream centerlines, 1:25,000-scale lakes and ponds (including wetlands), and digital topographic maps.

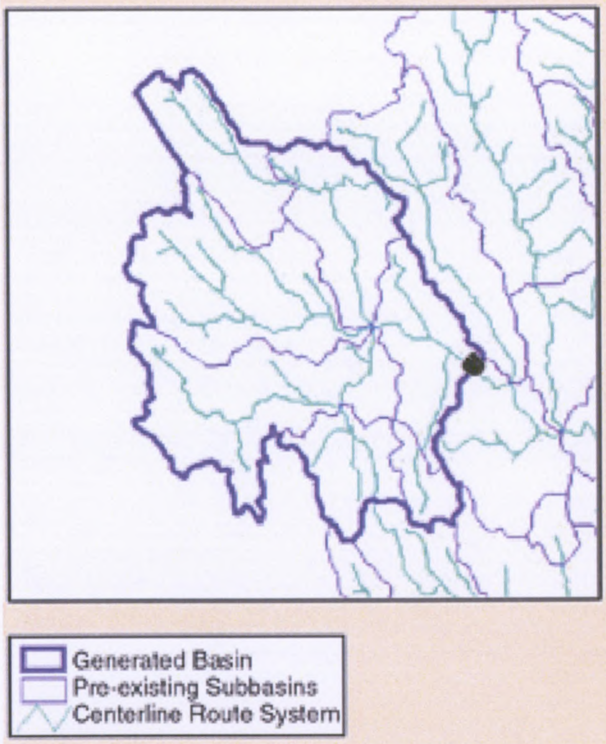
Users must first zoom in to select a location for which they want streamflow information. When the location of interest is a data-collection station, users should select the Station Lookup button, then click their left mouse button on the station symbol on the map to get streamflow statistics and descriptive information for the station from the data base. The map scale of an entire river basin is usually sufficient for selecting data-collection stations. When the location of interest is not a data-collection station, users should select the Low-Flow Analysis button, then click their left mouse button on a point on a centerline stream to get estimates of the statistics for the location. Users must first zoom in to a map scale greater than 1:5,000 and the centerline streams must be activated in the legend window before the Low-Flow Analysis button is selected.

STREAMSTATS output appears in a separate Web browser window that opens automatically. This window contains a table of previously published information for data-collection stations. The window contains a map, a map legend, measured basin characteristics, estimated streamflow statistics, and prediction intervals for the estimates for sites where no data are available (fig. 2). The map shows the generated basin boundary for the selected site, any previously delineated basin boundaries within the map area, and the centerline streams within the basin boundary. Users should carefully inspect the map and the measured basin characteristics for the site to assure that the basin delineation appears correct. Incorrect delineations occasionally occur when selected sites are in or near flat areas such as wetlands and water bodies, and near stream confluences. Moving the selected point a short distance upstream or downstream from the original location will often correct these problems. Users can use their Web browser to print the information displayed by STREAMSTATS.

LIMITATIONS OF STREAMSTATS

The equations used in the STREAMSTATS low-flow analysis procedure provide estimates of natural streamflow. If human activities such as dam regulation and water withdrawals substantially affect the timing, magnitude, or duration of flows at a selected location, the estimates from the equations should be adjusted by the user to account for those activities. The low-flow analysis procedure can be run at locations of data-collection stations on streams that are affected by human activities to obtain estimates of natural streamflow conditions for the stations. Users should not assume, however, that the differences between the two sets of estimates (data base and low-flow analysis) are equivalent to the effects of

Streamflow Statistics Report



Date:Thu Oct 07 17:57:31 1999
Latitude: 43.3239
Longitude: -73.0523
Measured Basin Characteristics:
Drainage Area (square miles): 25.73
Stratified Drift Area (square miles): 0.44
Stream Length (miles): 41.16
Slope (percent): 6.17
Region: 1

Statistic	Estimated streamflow, ft^3/s	90% Prediction interval	
		Minimum	Maximum
99-percent duration flow	1.21	0.35	3.88
98-percent duration flow	1.59	0.52	4.70
95-percent duration flow	2.35	0.88	6.01
90-percent duration flow	3.72	1.57	8.59
85-percent duration flow	5.11	2.28	11.25
80-percent duration flow	6.96	3.23	14.80
75-percent duration flow	9.38	4.40	19.75
70-percent duration flow	12.03	5.91	24.26
60-percent duration flow	18.81	11.27	31.19
50-percent duration flow	24.41	9.51	62.26
7-day, 2-year low flow	2.30	0.87	5.89
7-day, 10-year low flow	1.13	0.34	3.49
August median flow	5.53	2.44	12.34

Figure 2. Example output from the STREAMSTATS low-flow analysis procedure, including a map of the drainage basin determined for the user-selected site, a map legend, and a table of estimated streamflow statistics.

human activities on streamflow at the station because there are errors associated with both sets of estimates.

STREAMSTATS provides an error message when the basin characteristics for a selected site are outside the ranges of those for the stations used to develop the regression equations. Estimates can be obtained for these sites, but prediction intervals are not provided. The program does not provide estimates for sites on major rivers with drainage basins that extend into areas outside of Massachusetts where data for running STREAMSTATS are not available.

The regression equations in STREAMSTATS do not apply in the eastern part of the Buzzards Bay Basin, the southern part of the South Coastal Shore Basin, on Cape Cod, or the Islands, because the data available in these areas were inadequate for use in the regression analyses. Flows for most streams in these areas, shown as the Southeast Coastal region in the Hydrologic Regions data layer, are highly affected by regulation, diversions, or cranberry bogs. In addition, the region is underlain almost entirely by coarse-grained stratified drift. Surface-water drainage boundaries commonly do not coincide with contributing areas of ground water for streams in the region.

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Ries, K.G., III, and Friesz, P.J., 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water-Resources Investigations Report 00-4135.

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FOR MORE INFORMATION

http://ma.water.usgs.gov

U.S. Geological Survey
MA-RI District Office
10 Bearfoot Road
Northborough, MA 01532
telephone: (508) 490-5000
facsimile: (508) 490-5068

—By Kernell G. Ries III and Peter A. Steeves, of the U.S. Geological Survey; Aleda Freeman, of MassGIS; and Raj Singh, of Syncline, Inc.